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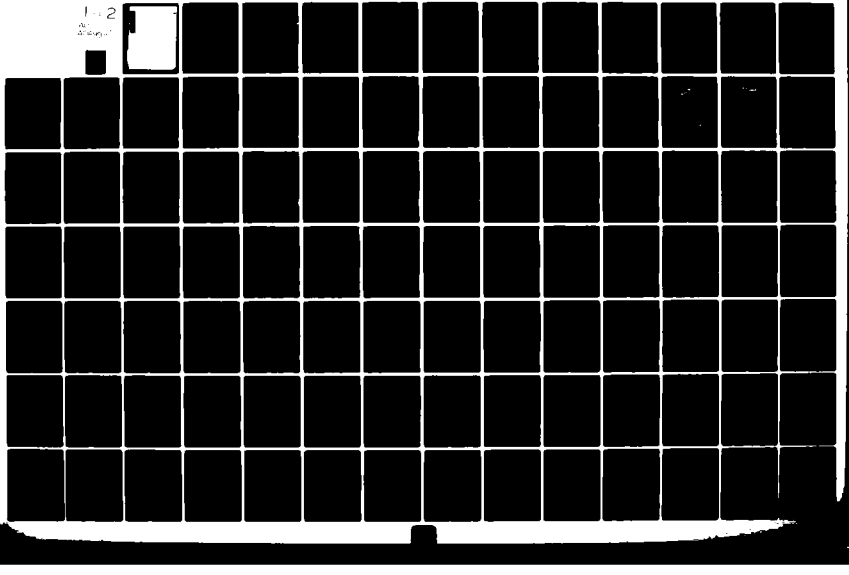

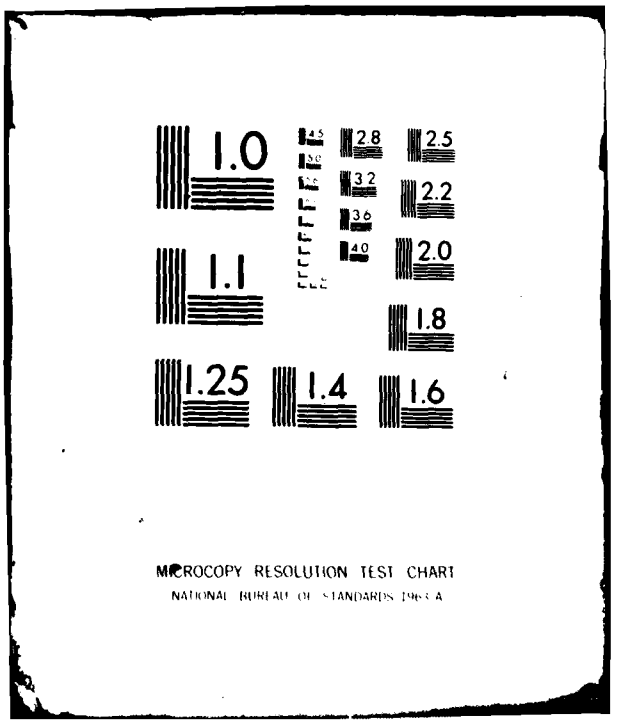
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This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of the staff of ONR Tokyo.

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Solid state	Energy
Semiconductor	Tokamak
Microwave	Stellarator
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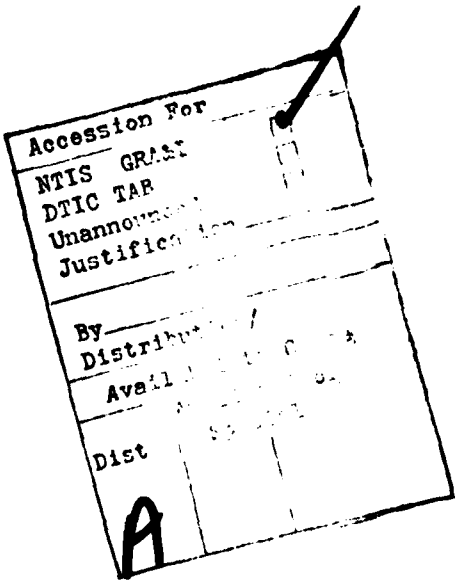
Gaseous electronics	Geophysics
Swarm experiments	Oceanography
Electrical discharges	Chinese journal
Ionization coefficients	Kexue Tongbao
Plasma physics	Scientia Sinica

20. Abstract (cont.)

with certain reports also being contributed by visiting stateside scientist. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.



CONTRIBUTORS

Harley J. Walker is Boyd Proffessor in the Department of Geography and Anthropology at Louisiana State University. During 1979, he spent a nine-month period in Japan as a Japan Foundation Fellow and as a guest professor at the University of Tsukuba. Dr. Walker's interests lie in the areas of arctic hydrology, coastal morphology, and coastal defense systems.

Hideo Yamanouchi is a faculty member in the Department of Geography, Gunma University, Maebashi, Japan. He is a coastal morphologist concentrating on coastal processes. During the first four months of 1980, he was a visiting scientist at Louisiana State University.

Eliot D. Cohen is head of the High Frequency Devices Section at the Naval Research Laboratory. He is responsible for the laboratory's development of microwave solid state devices and associated circuitry and also for assessing the reliability of microwave devices.

Leon H. Fisher, presently on the staff of ONR Tokyo, is on leave from California State University, Hayward. He recently completed an eight-year assignment as Dean of Sciences at Hayward, where he is also Professor of Physics. Dr. Fisher has held professorships at New York University and at the University of Illinois, has led research groups at the Lockheed Palo Alto Research Laboratory and the General Telephone and Electronics Laboratory, and has been visiting professor at the University of California, Berkeley, the University of Washington, and the University of Southern California. His specialty is gaseous electronics, and his interests include ionization coefficients in gases, mechanism of electrical breakdown in gases, formation of negative ions, corona discharges, and plasma physics. Dr. Fisher has recently coauthored articles on contact potentials.

Robert E. Stevenson is an oceanographer at the ONR Western Regional Office, resident at the Scripps Institution of Oceanography. He obtained a Ph.D. in marine geology in 1954 from the University of Southern California, and has held positions at Texas A&M University, Florida State University, and the Bureau of Commercial Fisheries. His current interests include coastal oceanography meteoroglogy, and climatology as well as the application of spacecraft sensors to analyses of surface-layer oceanography.

Francis A. Richards recently returned to his position of Professor of Oceanography at the University of Washington after completing a two-year assignment with ONR Tokyo. Dr. Richards' research interests in chemical oceanography include analysis of seawater, plankton pigments, oxygen-deficient and sulfide-bearing environments in the ocean, and interrelationships among the branches of oceanography through chemistry.

Seikoh Sakiyama, Scientific Affairs Specialist of ONR Tokyo, has had considerable industrial experience in laboratory chemistry, electronic instrumentation, and quality control methodology. His interests include computer science, linguistics, and energy technology.

Rudolph J. Marcus served 14 years at the ONR Western Regional Office in Pasadena before becoming Scientific Director of ONR Tokyo in March 1979. Special areas of concern during that time were photochemistry, photophysics, and computer control of chemical experimentation. Dr. Marcus served as founding secretary of the American Chemical Society's Division of Computers in Chemistry (1974-79). His papers on photochemical energy conversion in the 1950s are still being cited.

CONTENTS

COVER: "Koi-nobori," colorful carp streamers, are annually flown by Japanese families to celebrate Boys' Festival on 5 May. The carp symbolizes courage and power to attain high goals. This is a black and white reproduction of a colored "kiri-e" done by Eunice Mohri of the ONR Tokyo staff. Kiri-e (formally known as "kusa-e") is a modern Japanese art form using the "cut and paste" technique to create collages from handmade Japanese paper colored by natural plant dyes.

THE PEARL RIVER DELTA

H. J. Walker

A four-day field trip in September, 1979, provided an opportunity to observe the physical, biological, agricultural, and economic contrasts that occur throughout the western part of the Pearl River delta (Figure 1). The field trip, sponsored by the Estuary and Coastal Section of the Department of Geography, Zhongshan University, and the South China Sea Institute of Oceanology, was conducted in a Chinese-type landrover that could hold up to ten people.

The participants included, besides the driver and the author:

- Dr. Yeh Hui, Professor and Head of the Estuary and Coastal Section, Zhongshan University, geomorphologist;
- Mr. Huang Jin, Associate Professor and Vice-Chairman, Department of Geography, Zhongshan University;
- Mr. Li Chun-chu, Estuary and Coastal Section, Zhongshan University, sedimentologist;
- Mr. Zhao Huan-ting, Chairman of the Laboratory of Coastal and Estuarine Processes, South China Sea Oceanology Institute, sedimentologist; and
- Madame Shih Xiao-yuan, interpreter.

At most stops, one or more local specialists and one or more commune or brigade officers would join the group.

The four-day trip involved the crossing of many canals and river channels, eight of which had to be by ferry boat. The group was very congenial, talkative, and informative. The Chinese offered much general as well as specific information and, insofar as I could tell, answered all questions without any hesitation and to the best of their knowledge. I used a tape recorder which they thought was a good idea and seemed to enjoy. Also, there was no restriction on photographs. In the course of the four days, I recorded what came out to be 47 typed pages of notes and took 425 35-mm slides. The only major difficulty was one of time.

THE PEARL RIVER AND ITS DELTA

The Pearl River delta (frequently referred to as the Canton delta) is quite different from most deltas of the world. Fed by three major rivers at or near its head, the Pearl River delta drains into the South China Sea through eight major distributaries (Figure 1). These distributaries are separated by the Chung Shan, a circular mountain block around which deltaic sediments are accumulating.

The tributaries are quite uneven in length, discharge, and sediment load. The Si-kiang (West River) is by far the most important. It is nearly 2,000 km long and might be considered South China's counterpart of the Yangtze (Central China) and the Hwang Ho (North China). Of the total discharge in the Pearl River system (302×10^9 m^3/year or an average of over 9,500 m^3/sec-(cms),* 78.2% is contributed by the Si-kiang. The other two major tributaries are the Bei-kiang (North) with 12.8% of the discharge and the Tung-kiang (East) with 8.5%. There are a few smaller tributaries such as the Liu Qi, but, combined, they only account for about 0.5% of the delta's water supply.

*Data used in this report were supplied during the field trip, especially by Mr. Zhao and Professor Yeh.

The maximum discharge of the Pearl River system is over 70,000 cms, second only to and nearly equal with that of the Yangtze. Discharge in the Pearl system is highly seasonal--some 77.7% of its annual volume occurs in summer between April and September.

The suspended load is even more extreme; 94.6%, of the annual amount of 72,500,000 tons, is carried through the delta during the summer six months. Although the discharge of the Pearl system is similar to that of the Yangtze, its load is only about one-tenth as much. Nonetheless, the sediment load has been sufficient to construct a delta that is over 100 km in length during the past 4,000 or 5,000 years. The extension of the delta in the southerly direction has filled in Huang-mao Bay, near Ai Nan (Figure 1), where a major reclamation project is hastening the process (see below).

The rate of advance of the delta into the South China Sea can be determined in large part by the delta's occupational history. It is common practice to name new settlements after some local feature. In the case of coastal locations, coastal terms are usually used. In the Pearl River delta, inland cities such as Nan Hai (meaning "south sea"), Wai Hai (meaning "offshore"), and Chiang-men (meaning "watergate" and located 50 km from the present mouth of the river) are common. At the time they were established, all were at the front of the advancing delta.

RECLAMATION AND DELTA DEVELOPMENT

Just how long man has been cultivating the deltaic soils in South China is unknown. However, apparently it has been well over 1,000 years. During most of this time period, he expanded his agricultural territory with the natural advancement of the delta and also adjusted his practices to the seasonal flooding that is quite extreme in the Pearl system. Early, he learned two major ways to adjust to both of these conditions. One was by constructing levees to prevent flooding, the other by constructing dikes to accelerate reclamation.

Many of the early developments are lost in history and are not recognized by present-day populations. By 1950, the Pearl River delta had over 1300 km of levees and dikes, some as much as 7 m high and 4 m wide. Since 1950, others have been added. After severe flooding in 1959, for example, a levee system, utilizing 700,000 m^3 of earth, was constructed.

Many of the recent developments have been in Hsin Hui County, a county about 500 km^2 in area and with a population of over 800,000. According to Madame Shih, the reason for extensive construction of levees in this county is that "the people were quite poor because there were no levees; when the floods came, all was destroyed." Levee construction and agricultural improvement, including water management practices (both for irrigation and drainage), have been great in the county. The most recent development, however, is related to reclamation rather than flood protection.

The Chinese in the Pearl River delta have a saying that reflects their knowledge about the natural sequence of events during deltaic advancement: "yii you, lu po, huo li, cao pu" which means "fish swim, rudders touch bottom, cranes stand, grass spreads." They have been accelerating the process wherever and whenever possible through reclamation.

THE AI NAN RECLAMATION PROJECT

The two western-most distributaries of the delta join each other at the head of Huang-mao Bay. This bay, which is bordered on the west side by a mountainous area (Ai Nan means "South of the Cliff"), is shallow except near its head where it is 27 m deep. The bay is also small (about 300 km^3) and decreasing rapidly in size because of natural sedimentation. Because of its shape and shallowness and because of the river's sediment load, it is an ideal location for reclamation.

About 10 years ago, an investigation as to the feasibility of a reclamation project in the bay was initiated. Although reclamation was of top priority, a second factor had to be kept in mind. The western distributaries in

the delta are very important navigation channels. Therefore, any reclamation project had to be developed so that it would not destroy the existing channels and, preferably, so that it would improve them.

Very few data existed; there was no hydrologic station in the area. Before any measurements were made, local fishermen were questioned. It was learned that three major subaqueous bars (ranging from 4 to 6 km in length) extended across much of the bay in a nearly west-east direction, subparallel to the western shore. It was around these bars that *in situ* measurements were made in 1972 and 1973. During the measurement period, it was discovered that the sediment load in the bay is higher during flood tide than ebb tide, and it was decided to utilize this condition to aid in the reclamation process. Choosing the middle bar as the outer edge of the present reclamation project, the Chinese engineers constructed their dike so that it is submerged at high tide. This procedure allows tidally-raised water to enter and be trapped during ebbing flow. It is planned to allow this dike (completed in 1979) to serve as a trapping device for about 10 years, at which time it will be heightened and the reclaimed land drained.

When this diking system is completed, a total of 51 km^2 of new land will have been placed under cultivation. It is believed also that the dike's location is such that the navigational channel south through the bay will be deepened naturally.

Although the major step in this present plan will be realized only after another 10 years, a portion of the plan has been completed. The area nearest shore (about 8 km^2) has already been reclaimed. Dike construction was begun in 1976 and completed in 1978. The first crops (rice and sugarcane) were planted and harvested in 1979. The speed with which utilization was made possible was mainly because of a very rapid flushing of salts from the reclaimed land.

In 1970, construction of a hydroelectric project was begun in the Kudo Shan, a mountain system just to the west of Ai Nan. The project was designed primarily to provide electricity to the surrounding area, and secondarily to provide irrigation water for the reclaimed land.

The project was completed in 1973 after 6,500,000 work days (i.e., the equivalent of 6,500 people working continuously for 1,000 days). It was accomplished by the entire working force of county's different communes taking turns. Involved was the movement of able-bodied persons to the site for periods of three months during the construction period. It took the first 100 days to build the road system used during the construction period. Eleven reservoirs and 20 power stations were constructed; the total power production is about 10,000 kw.

Because these reservoirs were completed before the first of the Ai Nan reclamation areas was diked, water was available for flushing purposes. Flushing was achieved by allowing water to flow into the reclaimed area continuously, draining it from the area at low tide. It was stated that this continuous method of flushing was so effective that crops were planted within 45 days after it was begun.

The crops I saw in September, 1979, did not have the neat, well-groomed appearance observed elsewhere in the delta. The newness of the operation was obvious.

DELTAIC AGRICULTURE

Although Ai Nan agriculture shows signs of its recency, plans call for eventual diversification. The trip provided the opportunity to observe how traditional food crops were integrated with industrial crops and aquaculture. Following are brief accounts of two of the communes visited to suggest variety of pursuits and degree and type of utilization of the deltaic environment.

Le Liu Commune (Figure 1) is a long-established, well-developed agricultural area of about 40 km^2. It is divided equally into fish ponds and agricultural land. Major crops are rice, sugarcane, and mulberries; the silkworm industry is important in this commune. The climate allows year-round silk production, although there is a seasonal difference. The silkworm cycle, which is 20 days long during summer, is 30 days in winter.

Possibly the most interesting feature of this commune is its emphasis on fish. There are about 7,000 ponds in the commune, producing about 3,500 metric tons of fish per year. The ponds, which average less than 2 m in depth, were made by transferring deltaic sediments to adjacent agricultural fields. Thus, in this commune, the fields have been built up by an amount equal to the depth of the ponds with an improvement in their drainage characteristics. The ponds vary in size according to the size of the fish grown in them. In this commune, there are five steps or sizes involved after the hatchlings (which are also spawned within the commune) are placed in the first pond. Periodically, they are transferred to the next larger pond until considered of commercial size. The Chinese refer to these ponds as kindergarten, primary school, secondary school, high school, and university. The fish may fail at any step and have to repeat. Each transfer is replaced by the same number so that a consistent quantity is always produced.

The four most important species of fish produced in these ponds are:

- *Ctenopharyngodon idellus* (Cuvier et Valenciennes), *cao yu*, "grass Fish";
- *Aristichthys nobilis* (Rich.), *yong yu*, "big-head fish";
- *Hypophthalmichthys molitric* (Cuv. et Val.), *lian yu* or *bai lian*, "White fish"; and
- *Cirrhinus molitorella* (Cuv. et Val.), *tu ling yu* or *ling yu.*

Two pond fish of lesser importance are:

- *Cyprinus carpiol, li yu*, "carp"; and
- *Carassius auratus, ji yu.*

Upon "graduation," some are eaten within the commune, but most are shipped out live. First, they are placed in the bottom of one of the small canal boats which contains fresh water, next, they are transferred to a river boat, and eventually to a junk which takes them live to Hong Kong.

A second example is at Li Lo near Hsin Hui (Figure 1). In this commune, concentration is on rice, sugarcane, fan palms, and a variety of lesser crops. The area was subjected to extreme flooding until 1957, when a major system of levees was completed. During the past 20 years, much effort was expended in leveling the land between the levees, dividing it up into uniform areas, and developing an efficient irrigation and drainage network.

The commune is sufficiently close to the ocean so that the eight river channels that flow through it are affected by tides. This is especially important in winter (i.e., during low-river stages) when the tidal-induced salt-water wedge raises the river water sufficiently high to allow fresh water to be drained from the surface into the fields. It is a practice (known as *toudad*, i.e., "stealing") that is quite common in South China and one that was used in Georgia and South Carolina in the early 19th century.

Two other striking environmental adjustments observed in this and other areas of the Pearl River delta might be cited. Throughout the delta, and much of China for that matter, bricks are a major building material. In the delta, brick factories are numerous (in one commune of 44,000 population, there are 28 brick factories). Because of the nature of the sediments in the delta, they can be established almost any place where needed. When finished at a particular location, the area from which the clay was obtained is converted into a farm pond just as are the borrow pits that line all roads. Bricks in this region are not only used in most structures but also for subsurface drainage in rice fields.

Although water buffalo are used to a great extent in the Pearl River delta, the most important domestic animal is the pig. In many communes, pigs and people are about equal in number. Such numbers of pigs require large quantities of food. One of the most commonly used foods for pigs is the water hyacinth. When told that, in the southern United States and in southern Japan, the water hyacinth is considered a nuisance, the Chinese were very surprised. In the Pearl River delta, with the great human control over most land and water areas, wild water hyacinth does not get out of hand, and, indeed, the need is so great that it is cultivated. Freshwater fish are also used as pig food.

CONCLUSIONS

The above are only a few examples of "life" in a part of the Pearl River delta, but I think they are sufficient to show that the Chinese have modified the environment to meet their needs. Much of this modification has been done by trial and error, most of it by minimal inputs from science. What has been involved is a large labor force, one that not only could do all the manual labor involved but also, in more recent years, keep precise records. With such record keeping, the trial-and-error method has led to rather precise inputs and rather uniform harvests, whether of cultivated fish, silkworms, or rice.

The major interference with this controlled system appears to be the occasional typhoon that strikes the delta area. However, even with it, because of the fast growth rate of the crops involved, recovery is fast.

Many (if not all) of the communes now have research stations. The one visited has 37 people on its staff. The head is a young man with a high school education. I was told that the main objectives of this station are to:

- introduce new species.
- conduct interbreeding experiments,
- utilize irrigation waters "scientifically,"
- experiment with insecticides, and
- improve animal husbandry practices.

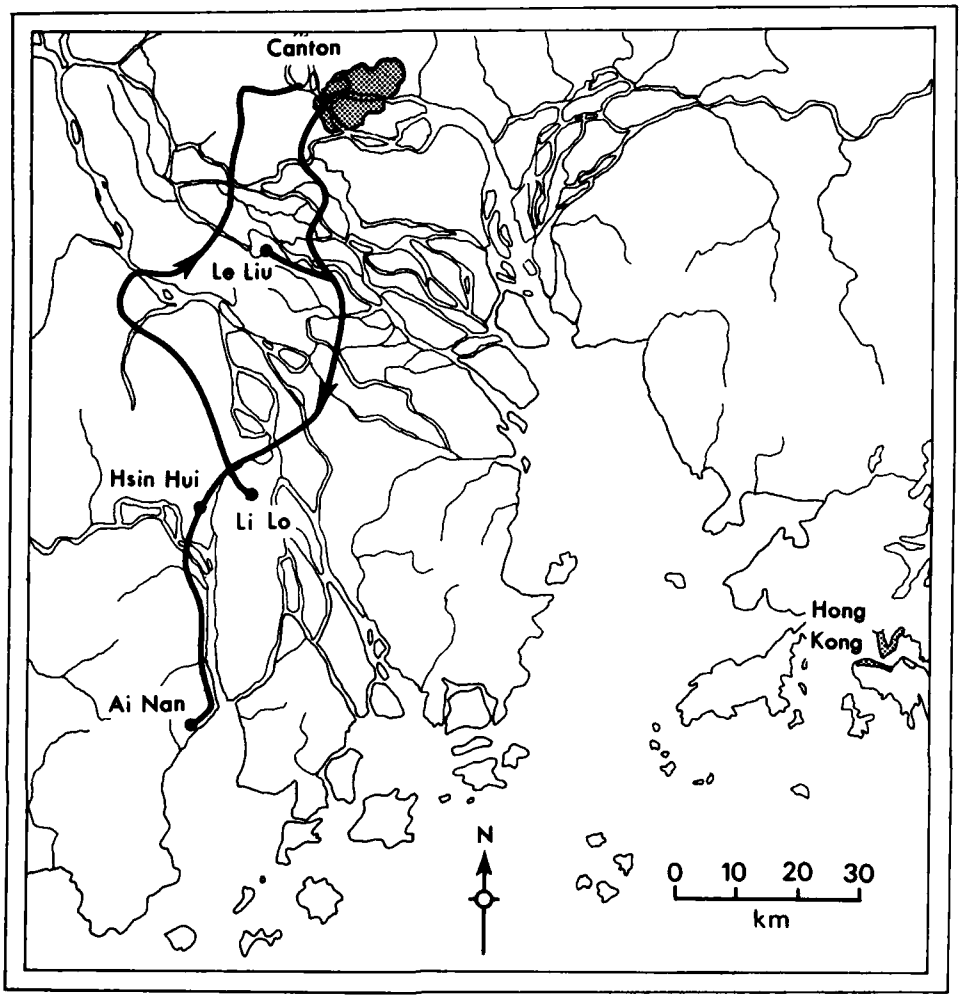


Figure 1 – The Pearl River delta and the four-day field trip route

ZHONGSHAN UNIVERSITY AND THE SOUTH CHINA SEA OCEANOLOGY INSTITUTE

H. J. Walker

In September, 1979, the author had the privilege of visiting the Pearl River delta. The Department of Geography, Zhongshan University, and the South China Sea institute of Oceanology, Academia Sinica, served as hosts. The visits included a day-long tour of each of these group's facilities and a four-day field trip of the delta (the subject of a companion article).

ZHONGSHAN UNIVERSITY

Zhongshan University, formerly known as Sun Yat-sen University, is like many other universities in China in that it is run by a committee that receives its instructions directly from the Ministry of Education in Beijing. It is one of the oldest and most highly respected universities in the country and, like the others, suffered greatly during most of the past 15 years. Zhongshan University is one of the 88 "key" institutions (out of some 600 in China) that were restored in March, 1978, by the PRC government. This restoration carries with it preferential treatment, including funding for both teaching and research. These institutions will also be able to mount major graduate programs. Of these key institutions, seven of the universities are comprehensive in nature–Beijing, Fudan (Shanghai), Kirin (Changchun), Nankai (Tientsin), Nanjing, Wuhan, and Zhongshan.

Since Zhongshan University was reopened, it has admitted about 1200 students per year and, in the fall of 1979, had nearly 5000 students on campus, about 300 of whom were graduate students. The faculty numbers over 2000, thus providing a teacher/student ratio of better than 1/2.5. It is anticipated that enrollment will double by 1985 and that the graduate student body will number 2000. The projection for China as a whole is 3,000,000 undergraduates by 1985.

Before the Cultural Revolution, Zhongshan University was composed of five colleges; today only two remain. These are the College of Social Sciences with five departments (history, economics, philosophy, foreign languages, and Chinese) and the College of Natural Sciences with eight departments (physics, meteorology, chemistry, geology, mathematics, computer science, biology, and geography). The university also has interdisciplinary groups. One of the most important of these is the Institute of Environmental Science, which has members from the departments of biology, chemistry, geography, and physics. It is currently headed by Professor Tsao Ting-fan, head of the Department of Geography. Presently there is only one other institute of this kind in China and it is located in Nanjing University.

THE DEPARTMENT OF GEOGRAPHY

The Department of Geography at Zhongshan University was founded in 1929 with the assistance of two German geographers, one of whom was the well-known geomorphologist W. Credner. It was the first department of geography established in China and has produced many of the present-day leaders in the subject. The first graduating class included Mr. Yeh Hui, who now heads the Estuary and Coastal Section at the University (see below). The second graduating class included Mr. Huang Ping-wei, the leading geographer in China today. He is the director of the Geographic Institute of Academia Sinica in Beijing and also acting president of the China Geographical Society. Mr. Huang has played a major role in opening up communication between geographers in China and elsewhere in the world–especially with the United States and Japan. He was the leader of a group of

10 Chinese geographers to tour the United States and to participate in a joint seminar in 1978. The seminar presentations, including a half-dozen Chinese-authored articles, are now in press.

Between 1929 and 1952, the department's offerings were quite general. However, during the 1950s, specific geographic topics began to be emphasized; in 1952, students could opt for a major in physical geography, and, in 1954, in economic geography. The next major developments did not occur until the 1970s. In 1972, a hydrology section was added, and, in 1974, programs in environmental protection (within physical geography) and city planning (within economic geography) were introduced.

The general reorganizations that are occurring in universities throughout China are reflected in the most recent changes in the Department of Geography. By 1978 it had five specialties—physical geography, economic geography, hydrology, geology, and meteorology. In 1979, both geology and meteorology became separate departments. Because of the newness of this separation, the functioning of these three departments varies from previous operation; they now share facilities, equipment, and students.

The Department of Geography is still the largest of the three as reflected in the following table:

	1978 Before Separation	1979 Geography	1979 Geology and Meteorology
Professors and Associate Professors	15	12	3
Lecturers	55	28	27
Assistants	49	36	13
Other staff	52	35	17
Total	171	111	60

After the split in 1979, geography had 175 students or about the same teacher/student ratio as the university as a whole. It can admit between 40 and 80 students per year. All department students take the same courses during the first two years. In their third year, they must choose an area of concentration.

The combined departments have 42 laboratories, one specimen room, one meteorological station, one hydrological station, and a library with 82,000 volumes. About half of the volumes are periodicals, 60% of which are in Chinese and 40% in foreign languages. Most of the equipment is very old and reflects long periods of both disuse and misuse.

Research in the departments has been concentrated on South and Southwest China and has, like its academic program, been pragmatic. Basic research has been incidental. One of the most active researchers in the department is Mr. Shen Tsan-hsin, whose specialty is a typhoon surge. During the past couple of years, he has issued six papers on the subject, including papers on the classification of surge types, prediction of surges, and long-wave theories as applied to surge forecasting.

An interesting side venture in the department is in the area of conservation. Near Kwangchon, at a place called Seven Star Hill, are some raised wave-cut platforms and notches. Because of their geomorphic significance, the department was successful in convincing the Chinese government that the area be preserved.

THE ESTUARY AND COASTAL SECTION

In 1964, the Chinese Government established a coastal and river mouth group within the Department of Geography. Before the Cultural Revolution, it had as many as 13 members, a number that dropped to two and one-half during the "cultural destruction period" (as one of my informants called it). This group was not only

rejuvenated but also upgraded, and now has section status. In 1979, there were nine scientists in the section, who are listed in the table below with their specialties.

Name	Specialty
Dr. Yen Hui (Head)	geomorphology
Mr. Yang Gan-ran	hydrology and physical oceanography
Mr. Wong Hong-shou	geomorphology
Mr. Li Chun-chu	geomorphology and sedimentology
Mr. Chen Jia-hu	physical oceanography
Mr. Lo Chang-ren	geomorphology
Mr. Chen Zhi-yong	sedimentology
Mr. Chen Shi-kwang	hydro-chemistry
Mr. Ying Yi-pu	estuarine hydrology

The first studies made by the group, when founded 16 years ago, were near the mouth of the western distributaries of the Pearl River system because of planned reclamation. Although only now getting reorganized, the section is taking up where it left off in its research in estuarine problems. It also is conducting research on coastal port location, shoreline and submarine topography, discharge and suspended load characteristics, and riverine flood control. The section members are cooperating with several other organizations, including the Conservancy Board at San-shui, about 45 km from Kwangchow, the Institute of Oceanography at Linhai, and the South China Sea Oceanology Institute.

During the flood seasons of 1978 and 1979, the section assisted in gathering hydrologic data within the delta's distributaries. Between 30 and 40 boats were used in data collection, data that are now being processed. Because of the limited capacity of the computers (owned by the Conservancy Board), much of the analysis is being done by hand.

SOUTH CHINA SEA INSTITUTE OF OCEANOLOGY, ACADEMIA SINICA

The South China Sea Institute of Oceanology, a division of the Chinese Academy of Sciences, was established in February, 1959. The Institute, under the leadership of Mr. Qui Bing-jing (Director) and Mr. Huang Yun-yao (Vice Director), consists of eight laboratories (coastal and estuarine processes, marine biology, marine chemistry, marine physics, marine sedimentation, new technology, physical oceanography and meteorology, and tectonics) and an Information Research Division. In addition, the Institute is in charge of three experimental stations. There are located in the cities of Zhanjiang and Shantow and on Hainan Island.

The Institute has a staff of about 600, most of whom work in a multi-storied building on the outskirts of Kwangchow. Each floor has been assigned to one or more of the laboratories, e.g., marine biology is on the third floor, the geologically-oriented fields on the fourth. Most of the laboratories have displays that show the type of research they engage in. The basement houses the Institute's computer. Although maintenance of a constant temperature and constant electrical flow is attempted, neither are very precise. The explanation given was that, in China, farming comes first, which includes demand on electrical output.

The Institute presently has an 80-m-long research vessel known as the Tsuyen. It is being joined this year (1980) by two other vessels which were under construction in 1979. Also under construction, in 1979, was a large buoy which will be capable of telemetering 13 data sets to a land-based station. This buoy will be used to record air pressure and temperature, wind speed and direction, and current velocity, among other variables. It is to be tested in June, 1980, in 20 m of water. If successful, it will then be deployed in 80 m of water and will be monitored from the Institute's field station in Hainan.

Other equipment, also much of it obsolete, includes a weather facsimile machine which is used especially during the typhoon season, a Chinese-manufactured x-ray diffractometer, and a satellite receiving system, the dish

for which is located on the roof. Being a part of the Chinese Academy of Sciences, the Institute is highly favored by the government and will be among the first groups to receive new equipment.

It is not an educational unit but does support occasional graduate students. During the past year, only five new graduate students were added. However, this number is due to increase and, in anticipation of this increase, a new dormitory for graduate students had just been completed.

Before 1966 (i.e., during the Institute's first six years of existence), research was concentrated on coastal and quarternary geology, physical oceanography of nearshore waters, coral reefs, the rearing of pearl oysters, and the development of marine optical instruments. Today, the Institute lists 16 principal research endeavors:

- Marine geophysics and geotectonics,
- Submarine geology and mineral resources,
- Coastal and estuarine geology and geomorphology,
- Coral reef geology and geomorphology,
- Submarine geomorphology,
- Sea water structure and ocean currents,
- Sea wave spectra,
- Sea air conditions and typhoons,
- Coral reef biology and ecology,
- Marine phytoplankton and zooplankton ecology,
- Marine plant and animal cultivation (especially, pearl oysters and porphyra),
- Harmful organisms (especially, barnacles),
- Marine organisms of medical significance,
- Estuarine and coastal water quality and pollution,
- Marine chemical element distribution and variations, and
- Application of new marine techniques.

It is anticipated that to this list will soon be added the application of remote sensing techniques in marine investigations and the study of marine productivity, among others.

SHANGHAI NORMAL UNIVERSITY AND ITS ROLE IN ESTUARINE AND COASTAL RESEARCH*

H. J. Walker

As reported in the *China Exchange Newsletter*, Volume 7, No. 2, April, 1979, the PRC Government in March, 1978, restored "key" status to 88 institutions of higher learning. Among this group are two normal colleges: Beijing Normal and Shanghai Normal. These two "colleges" are in essence universities and are often referred to in that way. Indeed, the newest publication (see section on Publication) from Shanghi Normal carries "University" in its title.

Shanghai Normal, formerly known as Hwa-tung College, was established in 1951. Today, it is well on the road to recovering from the difficult times endured by all academic institutions in China. In the fall of 1979, the University had 13 departments, 1,200 teaching faculty (including about 120 professors and associate professors), and 5,200 students. There were about 250 graduate students enrolled in special study courses that did not lead to an advanced degree. There were no foreign students enrolled in 1979, but some are anticipated by 1980. Shangai Normal originally was divided into colleges with deans. This structure was abolished and presently the heads of the 13 departments report directly to the vice-presidents.

In addition to the 13 departments, Shanghai Normal has four major research institutes, a correspondence unit, and a division specializing in communications that is housed away from the main campus.

THE DEPARTMENT OF GEOGRAPHY

The Department of Geography at Shanghai Normal, considered to be one of top departments in China, is headed by Dr. Lee Chun-fen. Lee, who received his Ph.D. in Canada, is also a vice-president at the University. The department has an instructional faculty of 97, including nine professors and associate professors, 62 instructors, and 26 teaching assistants.

The professorial group (with specialties in parenthesis) are:

- Lee Chun-fen: chairman of the department and vice-president of the university; he also is an officer in several Chinese geographical associations (physical and world geography);
- Chen Chi-yu: head of the Institute of Estuarine and Coastal Research; he is also chairman of the estuarine and coastal research committee of the Chinese Geography Association; teaches graduate courses in the department (estuarine and coastal dynamics);
- In Ou-shun: head of the topography laboratory and of the deltaic geology laboratory; he is also head of the topography committee of the Chinese geography association (topography, oceanic geology);
- Lu Lu-chen: head of both the Chinese geography laboratory and the agricultural geography laboratory (agricultural geography);
- In Chung-ming: head of the world geography laboratory (urban geography);
- Chou Su-jen: head of the meteorology and climatology laboratory (urban climates);

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*Much of the information in this article is from two hand-written documents given me by Vice-President Lee and Professor Chen. They are both in Chinese and were translated by Miss Chi Chi Hong, a student at Louisiana State University.

- Chu Shau-tang: head of the pedagogy laboratory (historical geography);
- Hu Huan-yung: (natural geography); and
- King Tsu-mong: (world geography).

In addition there are two vice-chairmen:

- Wu Chien-fen: instructor (world geography); and
- Liu Shu-jen: instructor and head of the applied remote sensing laboratory (remote sensing and geomorphology).

The enrollment in geographic programs in 1979 was 299 undergraduate and 22 graduate students. During its 28-year history, the department graduated nearly 5000 students. However, only slightly more than half were full-time students; the others were either part-time or correspondence students.

The students admitted to the university in China are quite select. Upon graduation from high school, all students take examinations that determine their future. Only the top few percent are permitted to enter a university. Those in the next category are used in industry and the group with the lowest scores are placed on farms.

The department consists of nine academic sections (usually referred to as teaching laboratories); namely: cartography, Chinese geography, environmental protection, geology, hydrology, meteorology and climatology, pedology, pedagogy, and world geology. It also has five research sections (scientific laboratories): agriculture, applied remote sensing, deltaic geology, environmental geography, and world geography. A number of specific research topics are now being pursued within these general research sections. Some examples are the historical geogrpahy of the Yangtze area, the remote sensing of the Yangtze estuary, riverbed processes, soil salinity, coastal topography, urban climatology, and pollution in the Whangpoo (the tributary that flows through Shanghai).

The department shares a multi-storied building with biology. It is located in the center of the campus and faces an imposing statute of Chairman Mao. Geography has its own library, which, is divided into four parts: two reference rooms (one with Chinese, one with foreign publications) and two reading rooms (one with Chinese, one with foreign publications). Like all other universities in China, its collection is much out of date. It has between 30 and 40 separate rooms for such activities as mineral and fossil display, cartography, photo interpretation, map printing, soil chemistry, rock and mineral analysis, and weather observation (including telex), among others. It also shares several laboratories with the Institute of Estuarine and Coastal Research (see below). The equipment in its laboratories is old and most of it needs replacement. Fifteen years ago, it was one of the best-equipped earth science departments in the country and, because it is one of the "key" institutions, will be once again. Soon to be added are items such as a digitizer and x-ray diffractometer.

INSTITUTE OF ESTUARINE AND COASTAL RESEARCH

In 1957, a Laboratory of Estuary and Coastal Research was established within the Department of Geography, with the cooperation of Academia Sinica. It served in this status until it was given full institute status in 1979. Today, the institute has four research divisions (laboratories) with a combined faculty and staff of about 50. These divisions with their key personnel are:

Administrators of the Institute
- Chen Chi-yu: head (estuarine and coastal dynamics);
- Chu Shu-jen: vice-head (geology);
- Yu Tse-in: secretary (geomorphology).

Coastal Research Laboratory
- Wang Pao-shan: head (geomorphology);

- Hu Fang-shi: vice-head (oceanography-especially tides);
- Chao Pei-kuei: (geomorphology);
- Kuo Cheng-tao: (coastal engineering);
- King Ching-shiang: (oceanography-especially wave dynamics).

Estuarine Research Laboratory
- Shan Huen-ting: head (hydrology);
- Chu Huei-fang: vice-head (hydrology, sedimentology);
- Hsu Hai-gang: (geomorphology);
- Ho Man-shan: (hydrologic engineering, modal testing);
- Su Fah-chung: part-time (hydrology).

Sedimentary Research Laboratory
- Chu Shu-jen: head, part-time;
- Liu Fa-tse: vice-head (geology);
- Lu Chung-jung: (geology);
- Hsu Shu-yuan: part-time (geomorphology);
- Gong Su-tsung: (geochemistry);
- Yang Chaio-wan: (palynology).

Applied Remote Sensing Laboratory
- Liu Shu-jen: head, part-time (geomorphology);
- Tse Tsai-sing: vice head (geomorphology);
- Huang Yung-dee: part-time (cartography);
- Mei Ann-hsing: part-time (geomorphology).

The institute cooperates with numerous other organizations, including the Ministry of Communication. Much of its research is conducted on the Ministry's many marine vessels. The largest of these, the Hang Pio No. 3., is 75 *m* long and is used for research in the deep water of the outer estuary. Although its main function is for such duties as buoy tending, it nonetheless is available for research much of the time. There are a number of smaller boats available for use within the shallower parts of the estuary.

As mentioned above, the institute presently is sharing laboratories with the Department of Geography, of which, until this last year, it was a member. Included are laboratories for sedimentology, atomic absorption spectral analysis, pollen analysis, and C-14 dating.

Most of the major research tasks of the Institute can be divided into the following five groups.

Tidal conditions in the Yangtze Estuary. Within this general research area, data are being collected on tidal flow, storm surges, river discharge, river flooding, estuarine circulation, water chemistry and temperature, and estuarine deposition. These studies have aided in the selection of ship channels, port and dock locations, and other shoreline developments.

Development and utilization of selected coastal areas. Many locations such as in Pohai Gulf, Haichou Gulf, Cheking Harbor, and Fukien Harbor are being studied. These studies are aimed mainly at providing a data base that will assist in determining the power utilization of the coastal area. Therefore, the studies are quite inclusive. All factors (geomorphic, oceanographic, biologic, and cultural) are examined. Lien-yun port, constructed after such a study, is considered to be quite successful.

Quaternary geology of coasts. The main objective of the institute's quaternary research is to determine the sedimentary history of the Yangtze estuary. Sedimentary cores have been taken and examined texturally, structurally, biologically, and chemically. The institute had a palynology laboratory prior to the Cultural

Revolution during which it was destroyed. They are presently reestablishing it and are also in the process of adding a C-14 laboratory.

Developmental history of China's coast. This major topic is also very extensive. Geological, geophysical, geomorphologic, quaternary, archaeologic, and historical approaches are being used. In 1978, a 42-page booklet containing eight short articles was printed. The articles are quite general. Seven of them begin with words "The evolution of . . ." Included are chapters on the Yangtze estuary, Pearl River delta, and Hwang Ho.

Remote sensing and estuarine problems. This phase of the institute's work was begun only two years ago. It is being done in cooperation with the Ministry of Communication's navigational research group. The institute, along with many other organizations, are anxiously awaiting the receiving station that the United States is helping to establish.

PUBLICATION

Once the institutions of higher learning in China were again allowed to operate, Shanghai Normal energetically regrouped. One of the strong indications of its faculty's desire to again become strong is the initiation of a University publication, *The Journal of Shanghai Normal University.* This journal has two editions, one a *Natural Science Edition,* the other a *Social Science Edition.* These editions are designed to report the research of the universtiy faculty. The *Natural Science Edition* includes articles written by members of the departments of biology, chemistry, geography and mathematics. The first number issued was for the natural sciences (identified as No. 1, 1978) and is 109 pages long. It contains 14 articles and three short notes. The articles are all in Chinese and there are no abstracts. The titles are, however, translated into English. As best I can tell from the titles, they are about evenly divided by subject matter, three each for chemistry and mathematics, and four each for biology and geography. The short notes describe a mini-computer, a analog-digital converter, and a grain moisture meter.

The second volume, for the Social Sciences, was in press when I visited the university in September, 1979. Vice-President Lee told me that the university plans on making the Journal a quarterly. This journal, one indication of the enthusiasm that seemed to be shared by all of the scientists I met at Shanghai Normal University, bodes well for university research in the future.

THE GEOGRAPHICAL SURVEY INSTITUTE: AN UPDATE

H. J. Walker and H. Yamanouchi

The article, "The Geographical Survey Institute: The Mapping of Japan" (H. J. Walker, *Scientific Bulletin*, Volume 2, No. 1, 1977, pp. 10-17) noted that "The difficulties inherent in cramped, outmoded quarters will soon be relieved (because) GSI is scheduled to make its move from the Tokyo site to Tsukuba, 60 km to the north, in 1978." That move has now been made. Therefore, it appears appropriate to provide an update on the institute, its facilities, and its services.

In the 1977 article, emphasis was placed on the history of map making in Japan and on the history and organization of GSI. After discussing briefly the changes that have occurred in the past four years, this article treats three functions of the institute: its oceanic and coastal work; its public service and international activities; and its publications.

THE NEW SITE

The Geographical Survey Institute facilities are now situated in the "Tsukuba Academic New Town" (also called "Tsukuba Science City"). This "city," located on former farm land, is about 20 km long and 8 km wide. It contains many of Japan's national institutes, laboratories, surveys, observatories, and the University of Tsukuba. It is one of the most visited locations by foreign scientists to Japan and is increasing in importance as scientific units move to it. Presently, there are over 40 major organizations that have been moved to Tsukuba Science City, including GSI.

The GSI is located on the northwestern edge of the complex adjacent to the university. It occupies about 2×10^5 m^2 of area and consists of 16 administration and research buildings, towers, and ponds (Figure 1). All of the institute's Tokyo personnel are now at Tsukuba except for ten persons who were left behind in order to handle triangulation leveling in the Tokyo area. At the time visited (November, 1979), all facilities were operational except for the gravimetric laboratory (No. 12, Figure 1), and it will become functional in 1980.

ORGANIZATION AND ADMINISTRATION

Although newly moved, GSI nonetheless has maintained its basic organization including its eight departments (administration, planning, geodetic, topographic, geographic, map management, crustal dynamics, and regional survey) and its geodetic observatories. Surprisingly, the number of personnel has decreased; from 941 in 1976 to 934 in April, 1979. The budget, however, has shown a steady increase. During the last five years it more than doubled, from ¥3.97 billion in 1974 to ¥8.10 billion (about $35 million) in 1979. Of this 1979 budget, almost half (¥3.92 billion) went to salaries and upkeep. The rest was distributed between the major units or projects of the institute with ¥1.50 billion to basic surveying and ¥1.67 billion to large-scale mapping. The coastal area survey program (discussed below) receives only ¥141 million (i.e., less than $650,000).

About a decade ago, when Japan's economy began to stabilize, dramatic changes began to occur within Japanese society. Because of changing societal demands, GSI began to emphasize the preparation of materials what would provide a better understanding of the landscape and thereby lead to more effective land use. The change in emphasis is reflected well in GSI's surveying activities along Japan's coastline.

GSI AND THE COASTAL ZONE

As reported in 1977, GSI is engaged in a number of activities that are oceanic in nature. Its geodetic department is responsible for tidal surveys and the monitoring of sea-level change. Some 23 mareographic stations along Japan's coast obtain continuous sea level recordings. In addition, the department is cooperating in the international geodynamics project on research in the western Pacific. One study is aimed at determining ocean floor expansion. In this research, GSI carries out traverse surveys of 4,200 km in length every three years in order to detect the horizontal extension of the Japanese islands.

In 1972, the GSI began a basic survey of the coast of Japan. This survey is aimed at supplying the data needed for rational development of the coastal zone. Concentration is on those coastal areas where development is being considered. The work includes the preparation of 1:25,000 topographic and land condition maps (thematic maps showing natural and cultural conditions) and of reports on the utilization, conservation, and control of the selected coastal areas.

Nearly all of Japan is already covered by 1:25,000 topographic maps and most of the principal plains (nearly all of which are coastal) are covered by 1:25,000 land condition maps. The major effort in conducting the basic surveys in coastal areas is one of extension from land out to depths of 50 m offshore.

The 1:25,000 scale topographic maps of coastal areas retain the same contents as the regular topographic maps for their land portions, although those buildings and public services concerned with the sea and added. In the sea areas of these maps, three groups of data are included: natural conditions (submarine contours, bottom materials, transparency, and the like); public facilities (ports and harbors, observatories, fisheries facilities, etc.); and administrative boundaries (harbor area limits, fishing zones, national parks, reclamation and dredging areas, etc.).

The 1:25,000 scale land condition maps of coastal areas are similar on their land portions to the already completed land condition maps. In sea areas, they include such items as thickness of alluvial deposits, bedrock types, sea depth, bottom materials, etc.

These maps are designed to aid in the selection of areas suitable for development, civil engineering projects, and those that should be conserved. They also provide basic data on the distribution of submarine resources (e.g., sand and gravel that is needed for construction) and marine resources (e.g., fisheries). They are especially valuable in maricultural enterprises and in pollution monitoring.

In order to produce such coastal coverage, traditional on-land survey techniques are inadequate. One of the most difficult areas to survey is near-shore, especially the breaker zone. Because of the dangers inherent in such surveying, GSI is experimenting with remote-controlled survey boats. It is also developing bottom sonar equipment that will aid in the analysis of the complex structures observed in the shallow waters around Japan and it is experimenting with the use of remote sensors in the surveying of near-shore pollution (Figures 2 and 3). Part of its anti-pollution testing activity is in cooperation with the Bureau of the Environment.

GSI also publishes lake charts and water use maps. Lake charts are prepared for use in connection with public water supply systems, industrial development, fisheries development, and lake transportation. Charts at a scale of 1:10,000 have been printed for most of the large lakes in Japan, with the exception of those in Hokkaido.

PUBLIC SERVICES AND INTERNATIONAL ACTIVITIES

GSI is first and foremost a service organization. The bulk of its service is realized through the maps it issues. However, there are many other ways it serves the Japanese. Japan is one of the most earthquake-prone areas in the world. Therefore, it is not surprising that earthquake predition is a prime research subject. GSI is only one of a number of institutes in Japan conducting research on this subject. In 1969, these institutes founded a

coordinating committee for earthquake prediction; since that time, GSI's coastal dynamics department has handled all the committee's secretarial activities.

Another administrative activity includes supervision of non-GSI agencies that become engaged in surveys. GSI checks plans and offers technical advice in order to reduce duplication of effort and to maintain required accuracy of public surveys. It conducts national examinations for surveyors and maintains a register of all who pass. Today's register contains information about nearly 30,000 surveyors and assistant surveyors who belong to more than 5000 private survey companies.

Among its most useful services is the access it provides to collections housed in the new facilities at Tsukuba. These include microfilms of all topographic maps issued from the time surveying began. Anyone needing copies of early maps can acquire them at a nominal charge. All collected data is conveniently filed and can be examined. For example, if one should desire to gather information about Japanese place names, mountain elevations, or length of protected coastline by prefecture, relevant data can be quickly retrieved. Surveying records and control point data (triangulation stations, bench marks, etc.) are filed in book form. Contact prints and microfilm of aerial photos can be ordered. Digital data on landforms, soil, rivers, and land use, among others are available from magnetic tape.

GSI has been cooperating with other nations for over 25 years. Since 1957, it has conducted courses for foreign surveyors and cartographers. Over 100 foreigners from more than 20 Asiatic, African, and Latin American countries have taken courses at GSI. Equally as important is the technical assistance GSI has given to many developing countries as illustrated in Figure 4. It has also been a participant in the conferences arranged by the Untied Nations Economic and Social Council, some of which have been held in Japan.

Its most recent activity in the international sphere is service in connection with the 10th International Cartographic Conference to be held in September, 1980, in Tokyo.

PUBLICATIONS

Without doubt, the most important publications issued by GSI are its maps. The annual volume of maps sold runs to about 8 million. The 1:50,000 series is most popular. In 1978, 4.3 million were sold, although this number was down from the 5.7 million record in 1973. Whereas the sales of the 1:50,000 maps are decreasing, sales of 1:25,000 maps are increasing. They increased from 2.0 million in 1973 to 3.5 million in 1978.

As one would suspect, maps of certain areas are much in demand. The Japanese travel a great deal and are avid map users. Maps are available throughout Japan in bookstores and at train stations. GSI's best sellers in 1:50,000 series are those of national parks or favorite recreational areas. The Kamikochi quadrangle, a national park that has mountain climbing, was bought by 21,248 people in 1978. Mount Fuji, with 15,092 sales, was 10th in popularity. The purchasers of the 1:25,000 series tend to be a different group. The top six are around Tokyo and number seven was Kyoto. The detail provided on these 1:25,000 series makes them ideal for use in densely populated areas. The prices of these 1:25,000 and 1:50,000 maps range from ¥120 to ¥150, depending on the number of colors used in their printing. An index map (in Japanese) showing all of them is available.

In addition to maps and aerial photographs, GSI issues atlases, research reports, informational brochures, and periodicals. All of its operating divisions are responsible for publishing occasional reports detailing the results of their activities. They range from mere compilations of data to research reports. Although it is impossible to enumerate all of the publications, the following list should provide an indication of the variety available.

- The National Atlas. This atlas is now complete and is comparable to that prepared by the U.S. Geological Survey. It consists of 180 sheets separated into 13 parts, and covers nearly all of the mapable aspects of Japan and its people. An English version is available and a brochure about it has been issued by GSI.

- In November 1979, GSI published a 31 X 43 cm, 340-page volume of color aerial photographs of Japan.

It contains 160 photographs that are 45 X 43 cm in size, i.e., each is designed to occupy 3/4 of a double page. The remainder of the space is used to describe the area depicted and includes a topographic map of the region. The scales of the photos vary, depending on the nature of the surface, from 1:1500 to 1:15,000. Most are of the 1:3000 to 1:5000 size. As one might expect, a large proportion of the areas selected are coastal and emphasize coastal utilization.

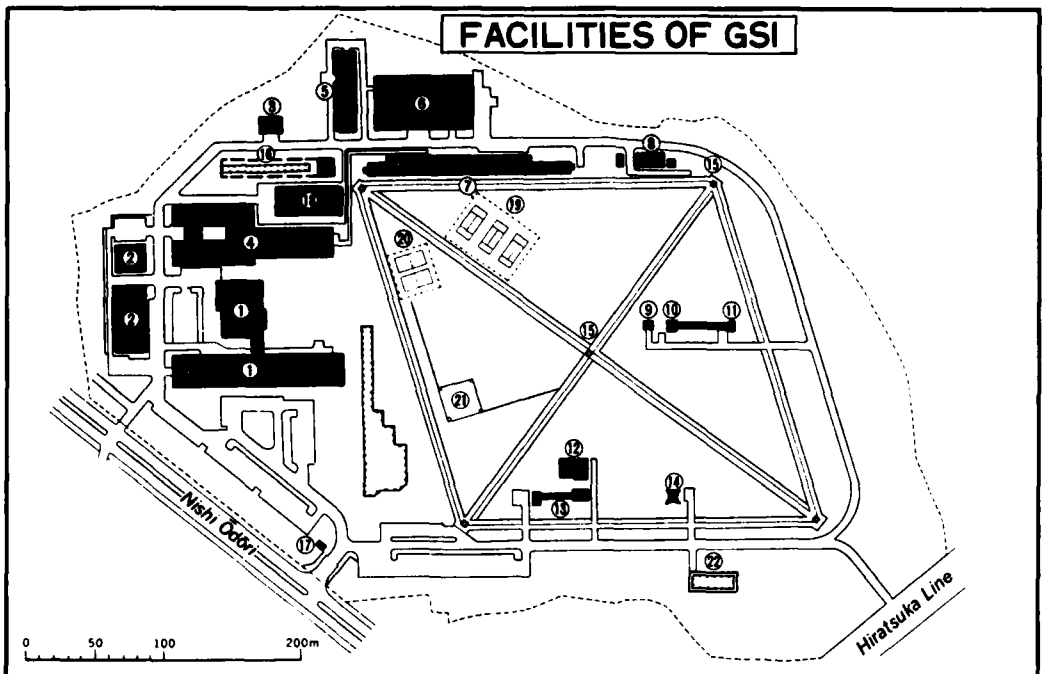
- The Institute has two major periodicals—one in Japanese and one in English. The one in Japanese is entitled *GSI Review* and is annual. Number 51 for 1978 has seven articles, including "The Difficulty of Mapping Isolated Islands," "How to Manipulate Leveling Results," and "How to Make Land Use and Landownership Color Photo Maps." The periodical in English is called the *Bulletin of the Geographical Survey Institute.* Although published at irregular intervals, 23 volumes, consisting of 61 numbers, have been issued since 1948. A recent issue (Volume 23, Part 2) contains five major articles with such titles as "Crustal Deformation Related to the Izu-Oshima Kinkai Earthquake of 1978," "Color Photomosaic by Digital Methods," and "Survey for Disaster Countermeasures Along National Highways."

- As mentioned above, all of GSI's departments issue occasional items. A few examples include: the planning department annually publishes a catalogue of map names, the geodetics department annually issues Japan's tidal records, the geographic department publishes reports about maps such as the one issued in 1975 entitled "Coastal Hazards in Niigata," and the crustal dynamics department annually issues reports on sea level change.

- Lastly, it is appropriate to mention the information brochures published by GSI. In 1979, a 52-page pamphlet in Japanese, entitled *Geographical Survey Institute* was printed. GSI also issues a brief version in English; the latest was to have been published in the Spring of 1980. If you write for a copy, also ask for a copy of the map entitled "Tsukuba Science City." In English, it includes inset maps of the area at different scales and a map of the facilities of GSI (this map is reproduced here as Figure 1), as well as a brief description of GSI. Order from:

  The Geographical Survey Institute
  Tsukuba Science City
  Ibaraki-Ken 305
  JAPAN

FIG. 1



NO.	NAME	NO.	NAME	NO.	NAME	NO.	NAME
①	Main Office Building	⑦	EDM Calibration Laboratory	⑬	Crustal Activity Observation Station	⑲	Tennis Courts
②	Annex	⑧	Astronomical Laboratory	⑭	Geodetic Observation Tower	⑳	Volleyball Courts
③	Film Warehouse	⑨	Absolute Observation Room (Geomagnetic Laboratory)	⑮	Rhombus base line	㉑	Baseball Ground
④	Reproduction Laboratory and Workshop	⑩	Variometer Room (Geomagnetic Laboratory)	⑯	Test pond	㉒	Swimming Pool
⑤	Remote Sensing Laboratory	⑪	Control Room (Geomagnetic Laboratory)	⑰	Gate		
⑥	Geographical Laboratory	⑫	Gravimetric Laboratory	⑱	Antipollution Control Station		

Figure 1. Geographical Survey Institute, Tsukuba, Japan (modified from "Tsukuba Science City").

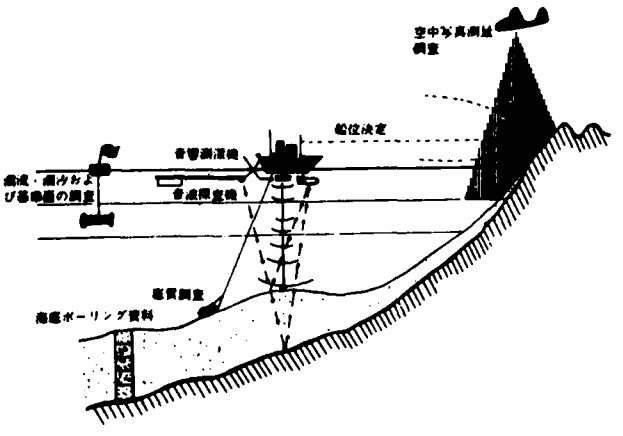


Figure 2. Methods of obtaining information for the new land condition maps of Japan's coastal zone (from the 1979 Japanese version of "The Geogrpahical Survey Institute" page 39).

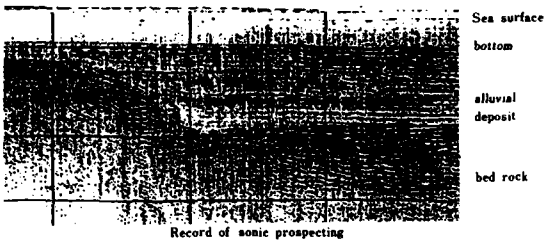


Figure 3. Sonograph record (from the 1977 English version of "The Geographical Survey Institute" page 20).

Area	Outline of Planning	1971	1972	1973	1974	1975	1976	1977
Indonesia the Barito River Basin	area 19,300 km² astronomical survey 8 stations leveling 360 km topographic map (1 50,000) 34 sheets	(I) aerial photograph	(II) ·control survey (including tide observation) ·aerial triangulation	(III) · mapping · field compilation · scribing	(IV) · printing · delivery			
Tanzania (Musoma Area)	area 12,730 km² traverse survey 25 stations leveling { first order 150 km, second order 650 km } topographic map 23 sheets (1 50,000			(I) ·aerial photograph ·control survey	(II) ·control survey ·field identification ·aerial triangulation ·mapping	(III) · mapping · field compilation · scribing · printing	(IV) · delivery	
Bolivia Chapare Area)	area 25,000 km² triangulation survey 4 stations satellite geodetic survey 21 stations leveling { indirect 900 km, 600 km } topographic map 44 sheets (1 50,000)				I · control survey · aerial photograph	II ·aerial photograph · control survey	(III) · control survey · field identification · aerial triangulation	(IV) · mapping · scribing · printing · delivery
Kenya Tsavo, Lamu & Malindi Areas)	area 27,000 km² traverse survey 16 stations leveling { second order 450 km, 1,000 km } topographic map (1 50,000) 38 sheets					I · aerial signal · selection of station	II · control survey · aerial photograph	III · Control survey · aerial photograph · up to 1979
Guinea Whole Country)	area 200,0000 km satellite geodetic survey 55 stations leveling { second 800 km, 800 km } topographic map 1 50,000 16 sheets							I · control survey · aerial photograph · up to 1981

Figure 4. Processing schedule for topographic mapping in foreign countries (from the 1977 English version of "The Geographical Survey Institute" page 30).

RESEARCH ON GALLIUM ARSENIDE FIELD EFFECT TRANSISTORS IN JAPAN

Eliot D. Cohen

INTRODUCTION

In May, 1979, I was selected by the IEEE-Microwave Theory and Techniques Society Group MTT-7 to serve as the American representative to an IEEE-IECE (Japan) Workshop on Microwave Solid State Devices. The workshop was held on 22 January 1980, in Tokyo. In addition to attending the workshop and presenting two technical papers, my trip included visits to the three leading manufacturers of gallium arsenide field effect transistors (GaAs FETs) in Japan: Nippon Electric Corporation (NEC), Fujitsu, and Mitsubishi Electric Corporation. This report describes the impressions I gained during my visit and some of the latest research results. In general, all of the Japanese scientists whom I met during my stay were exceptionally helpful and hospitable. In particular, Dr. Fumio Hasegawa of NEC, Dr. Kunihiro Suetake, head of the IEEE-MTT Tokyo Chapter, Drs. Masumi Fukuta and Hidemitsu Komizo of Fujitsu, Drs. Kyochi Shibayama and Sigeru Mitsui of Mitsubishi went out of their way to make my trip pleasant and worthwhile.

NIPPON ELECTRIC CORPORATION

I visited both the NEC Central Research Laboratory and Semiconductor (Production) Division on Monday, 21 January. Dr. Fumio Hasegawa was my host throughout the day. During the visit to the Semiconductor Division, Dr. Toshiaki Irie also served as host.

The most striking facet of the NEC operation is the huge number of GaAs FETs shipped each month: 17,000 devices fabricated from 450 wafers. The semiconductor division operates two factory shifts per day from 6 a.m. to 10:30 p.m. On microwave solid-state devices, 450 workers are employed, including 80 engineers and technicians. Final wire bonding and packaging of most devices is performed at another plant located in northern Japan to save on labor costs.

NEC, as well as the other two companies visited, concentrates on developing GaAs FETs for Japanese communication systems. Thus, most of the devices were either low-noise or medium-power types which operated over relatively modest bandwidths, e.g., 500-800 MHz. At the Central Research Laboratories, all microwave solid-state device research is performed on GaAs FETs. Work on GaAs Gunn devices, GaAs IMPATTs, and silicon bipolars, and on GaAs FET reliability is carried out exclusively in the Semiconductor Division. Vapor phase epitaxy is the mainstream material approach for both research and production, although research is also being done on the use of ion implantation into buffer layers. Many problems have been encountered with ion implantation. Molecular beam epitaxial growth was also investigated but dropped because it did not appear to provide advantages over VPE. Metal-organic chemical vapor deposition (MOCVD) is under investigation. Very pure material has been produced by using this technique, but active region epi layers have not been as good as those fabricated by VPE.

Most of the device research is centered upon packaged power FETs with internal matching structures. Recently, a huge (60.8 mm) total gate width device (1 μm gate length) was produced which yields 25 watts of power output at 6 HGz and 17 watts at 8 GHz. NEC uses an exceptionally deep (almost 0.5 μm) graded recess structure for these devices to improve breakdown voltage characteristics. NEC claims that an improvement in breakdown voltage from 8 to 18 volts for one device structure was obtained with a 0.2 μm recess. The active

layer thickness under the source and drain contacts is 0.5 μm. Doping is 1.2–1.5 X $10^{17}/cm^3$. ohmic contacts are Au–Ge/Ni or Au–Ge/Pt, and gate metalization is aluminum with a Ti–Pt–Au barrier between the gate and gate bonding pad. No N^+ layer is used under the ohmic contacts.

NEC emphasized the importance of "high packing density" (wider individual gate fingers but slightly more spacing between fingers) as the key to success in achieving 25 watts from a single device. Source lead inductance is minimized by completely metalizing the periphery and sides of the chip to provide a ground connection, i.e., no source wire bonds. However, in production, a ribbon lead arrangement is used for the source-to-ground connection to increase yield. Another NEC innovation is the use of source-over-gate crossovers, using a SiO_2 layer for isolation.

The 25-watt devices were packaged with internal matching networks to provide a 1-dB-bandwidth of approximately 500 MHz. (Similar internal matching networks have been developed for use at 14 GHz and 20 GHz.) The lumped element input matching network capacitors are formed on a barium titanate substrate (ϵ_r = 39) (inductors are wire bonds), and the distributed circuit output matching networks are fabricated on alumina.

Best results achieved were: 2.5 watts with 4 dB gain and 19% power added efficiency at 14 GHz and 1 watt with 3 dB gain and 10% power added efficiency at 20 GHz.

Another new development is a (nominally) 20 GHz small-signal monolithic amplifier which yields a minimum noise figure of 6.3 dB with 7 dB associated gain at 21.3 GHz. The 1 dB bandwidth extends from 20.5-22 GHz.

A "super low noise" small-signal FET was also produced which had a noise figure of 1.68 dB at 12 GHz.

NEC is also doing work on monolithic circuits for digital applications and optical devices.

Dr. Irie was particularly interested in work on power GaAs FET reliability at NRL. He stated that NEC is attempting to develop satisfactory "screens" to improve yield of reliable devices.

WORKSHOP ON MICROWAVE SOLID-STATE DEVICES

Aside from my invited paper on the "Status of Microwave Solid-State Devices and Analog Circuits in the United States," all of the other papers on Tuesday described GaAs FET developments. A few contributions on other solid-state devices, such as PIN diodes, GaAs mixer diodes, and the static induction transistor, were scheduled for presentation the next day. I did not hear these papers because of time limitations.

I also presented a paper, entitled "Reliability Assessment of Microwave Power GaAs FETs," which described our work at NRL. Japanese contributions to the workshop came primarily from two companies: NEC and Mitsubishi. This reflects the concentration of GaAs FET R&D at these concerns. Of the eleven Japanese papers, only two were from other organizations. The first of these was a paper from Matsushita on a UHF band dual gate GaAs FET for use in a television tuner, and the second was from NTT on the use of direct-writing E-beam techniques for producing GaAs MOSFET logic circuits. Notable results included those from NEC mentioned previously, plus several from Mitsubishi described in more detail below.

Summaries of all of the papers are available from me upon request.

FUJITSU

Dr. Masumi Fukuta was my host throughout the day on Wednesday, 23 January, at Fujitsu. In addition, I met most of the other scientists engaged in GaAs FET R&D at Fujitsu. The entire company employs approximately 32,000 people. Of these, 65% are engaged in computers, 25% in communication systems, and 10% in components. Total sales in 1978 were approximately $1.7 billion. Research laboratory personnel total 750, with 430 degreed engineers (50 Ph.D, 190 MS, 190 BS), 240 technicians, and 80 support personnel. The 1978

budget was $35 million. R&D is being conducted on GaAs FETs with particular attention focused on advanced technology for digital logic. All discrete GaAs FET development has already been transferred to the factory. Other devices under development include laser diodes, LEDs and avalanche photodiodes, Josephson junctions for computers, bubble memories, and ceramic materials. There is also a medical electronics group.

Digital GaAs FET logic circuits at Fujitsu were not as advanced as at Rockwell and HP. Best results were a 13-state ring oscillator with a delay of 70 pS and power-delay product of 100 fJ. Also, a frequency divider which operated well up to 60 MHz has been completed. For the logic circuits, both GaAs Schottky barrier and GaAs MOSFETs are being developed.

For power GaAs FETs, the advantage of deeply recessed gate structure was emphasized again, as at NEC. Fujitsu power GaAs FETs are very similar in design to those produced by NEC. However, Fujitsu has been extremely successful in producing an entire family of sapphire substrate hybrid MIC matching circuits which are used in conjunction with the device chips to produce tiny packaged power FET amplifiers in large quantities. Eighty amplifiers are fabricated on each 2″ diameter sapphire substrate. These balanced stage amplifiers only require one power supply because gate bias is controlled by resistance pads mounted in the center of each balanced stage. Fujitsu claims that their deep recessed gate GaAs FETs have such good linearity that large-signal performance can be very accurately predicted from s-parameter measurements. Thus, the family of GaAs FET hybrid MIC amplifiers are designed from 2-parameter measurements.

Fujitsu also emphasized the advantage of using gates with flared tops to provide a large cross sectional area and, thus, reduce gate current density. Their power FETs are fabricated on Cr-doped S.I. substrates from Sumitomo with thick undoped buffer layers grown by VPE. Active regions are also formed by VPE but N^+ regions are fabricated by MOCVD selective epitaxy and doped to about $3 \times 10^{18}/cm^3$. Ohmic contacts are Au–Ge/Au with no Ni and gates are Al with a Ti–Pt–Au barrier between gate and pad. The elimination of the use of Ni for ohmic contact development was considered very important from a reliability standpoint.

Fujitsu has produced a 1-stage, 12-19 GHz, balanced low-noise amplifier with 6 dB gain, a 3-stage, 4-12 GHz, 18-dB-gain amplifier, and a 3-stage 4-8 GHz, 20-dB-gain amplifier using the spaphire substrate matching networks.

They are doing substantial work on ion implantation for digital logic circuits and some work on MBE growth for a new type of microwave device which they would not discuss.

A trip through the production facility was conducted by Mr. Itoh. At Fujitsu, 170 wafers/month are used to produce 400-3000 GaAs FET devices per wafer for commercial applications. Silicon bipolar transistors are also produced in other rooms at the same facility. About 70 people work on the production lines for these two devices.

A particular impression gained at both NEC and Fujitsu was that equipment, in general, was adequate but not at the forefront of high technology. However, personnel (particularly scientists) appeared to be extremely dedicated, often working two-three hours extra every day except Wednesday. They are prohibited from working late on Wednesday by a union agreement.

MITSUBISHI

I visited this company on 25 January. Mitsubishi GaAs FETs differ considerably from those of NEC and Fujitsu in that they are "flip-chip" devices and of a different design. Substrate material is usually from Mitsubishi Monsanto but occasionally Sumitomo. Mitsubishi qualified its substrates for both low noise and power FETs by measuring their I-V characteristics. Higher breakdown voltage substrates are used for power devices; lower breakdown wafers for low noise devices. Substrates are also checked by photoluminescence for impurities. Buffer layers 2- to 2-μm thick are grown on the substrates followed by active layers, 0.3- to 0.4-μm thick with 2×10^{17} doping. Vertical furnaces allow large substrates to be used. Source-drain metalizations are Au–Ge/Ni, and gates are aluminum with a Cr–Mo–Au barrier between gate and gate pad. As is the case for NEC and Fujitsu devices,

gates are placed in a graded recess. The gates are positioned closer to the source than drain. This company uses a "delta shape" carrier profile for the active region formation. Devices are subjected to both thermal aging and burn-in before being shipped to customers. Mitsubishi claims to have achieved particularly low contact resistance (2×10^{-7} ohms for $10^{17}/cm^3$ material) by using a special heating technique. They also passivate their low noise devices to eliminate drain current drift.

Best low noise results achieved are 0.6 dB NF with 14 dB gain at 4 GHz, 1.3 dB NF with 11 dB gain at 12 GHz, and 2.1 dB NF with 6.5 dB gain at 18 GHz. Device gates were 0.7 μm X 200 μm and formed by conventional photolithography. Best power device results include 10 watts at 12 GHz from a 28.8-mm-gate device and 1.9 watts at 15 GHz from a 4800-μm-gate device. Power-added efficiencies are relatively low: 12-18%.

This company has devoted a considerable amount of effort to eliminating (catastrophic) failure modes. Electromotive force (EMF) imaging is used to identify locations of large electric fields. Devices have been tested for resistance to surge pulses, high CW, and long-pulse burnout. Temperature cycling tests from $-196^{\circ}C$ to $+200^{\circ}C$ have also been performed.

Mitsubishi is particularly involved in producing relatively high-performance dielectric resonator GaAs FET oscillators.

Latest laboratory research work involves material growth, using both MBE and MOCVD, and design of both analog and digital GaAs FET integrated circuits.

CONCLUSION

The companies visited are concentrating their microwave research activities on one device: the GaAs FET. They are particularly adept at producing very-large gate width GaAs FETs and have successfully established production capabilities for all but the largest devices. They have also done a great deal of work on hybrid MIC internal matching circuits for their packaged power FETs.

However, they lag in devleopment of monolithic analog and digital GaAs circuits and are not doing R&D on ultrawideband amplifiers. No work on InP microwave devices was being performed at any of the companies visited.

GASEOUS ELECTRONICS RESEARCH IN JAPAN

Leon H. Fisher

INTRODUCTION

Conduction of electricity in gases, electrical discharges in gases, gaseous electronics, and ionization phenomena in gases are all terms used interchangeably to describe the phenomena occurring in partially ionized gases. The terms "swarms" and "swarm experiments" are often used to describe a subset of phenomena within the broader subject, excluding arcs and high-voltage breakdown. The term "swarm experiments" is especially popular in Japan, whereas the term "gaseous electronics" has been used extensively in the United States since 1948. The present report emphasizes the swarm aspect of gaseous electronics in Japan, although comments are made about corona discharges and high-voltage breakdown. Hopefully, a report on high-voltage engineering in Japan will be forthcoming.

The initiation of swarm experiment research occurred at the end of the last century and was dominated for many years by the titanic figure of J. S. Townsend of Oxford University. He initiated most of the kinds of measurements which are still being made today; in many cases the techniques are identical with the ones he developed.

Some of the topics which are included under swarms and swarm experiments are:

- calculation and measurement of electron energy distributions in weakly ionized gases in the presence of electric fields;
- measurement of drift velocities of positive and negative ions in gases in the presence of an electric field;
- measurement of drift velocities of electrons in gases in the presence of and electric field;
- electron diffusion in a gas, both along the electric field and transverse to the electric field;
- back diffusion (the reflection of electrons by a gas and their absorption by a cathode when the electrons are photoelectrically emitted from the cathode);
- diffusion of ions in a gas;
- determination of the ratio of coefficient of diffusion to mobility for electrons and also for ions;
- attachment of electrons to atoms and molecules to form negative ions;
- detachment of electrons from negative ions;
- recombination of electrons and positive ions as well as recombination of negative and positive ions;
- ionization of atoms by electron collision in electric fields to form electron avalanches (first Townsend coefficient);
- ionization in electrical discharges by collisions of the second kind;
- determination of the second Townsend coefficient, i.e., ionization produced in addition to that accounted for by the first Townsend coefficient (production of secondary electrons at surfaces in a Townsend discharge by photons and by positive ions at the cathode); and
- afterglow phenomena (decay of ionization in a glow discharge once electric field is removed).

The following are usually not included in swarm experiments but are part of gaseous electronics:

- electrical breakdown in gases in uniform and non-uniform electric fields,
- corona discharges,

- glow discharges,
- electrical breakdown in vacuum, and
- arc discharges.

Strangely enough, transport of charged particles in liquids and breakdown phenomena in liquids are sometimes included in conferences on gaseous electronics.

Although work on electrical breakdown of gases has had a long history in Japan, it is only recently that work in the pre-breakdown region has been carried out. The present report is mainly limited to these areas which are new for Japan. Subjects such as high-voltage technology, including insulator surface flashover, high-voltage breakdown, high-voltage transmission problems, and lightning discharges are all being actively pursued in Japan and hopefully will be the subject of a subsequent report. These topics will be treated only tangentially in the present paper.

Thus, at the present time, there is considerable work going on in Japan in the general area of gaseous electronics. A large fraction of this work is being carried on by a cooperative research group whose activities are called "Refinement and Extension of Swarm Experiments." Some 17 laboratories throughout Japan are involved. The work is being supported by a grant-in-aid for scientific research from the Ministry of Education. Professor Iwao Ogawa, Department of Physics, Rikkyo University, Tokyo, is designated as head investigator of the research group, but might more properly be referred to as the coordinator of the group.

The following institutions in Japan are involved in swarm experiments at the present time. It is probably not a complete list. Principal investigators are also listed.

- Department of Electrical Engineering, Hokkaido University, Sapporo, Professors Hiroaki Tagashira, Saburo Sakamoto;
- Department of Nuclear Engineering, Tohoku University, Sendai, Professors Kunio Seto, Masahiro Takebe;
- Department of Electrical Engineering, Ibaraki University, Higachi, Professor Hiroshi Mase;
- Department of Electrical Engineering, Gunma University, Kiryu, Professor Minoru Sugawara;
- Department of Physics, Saitama College of Health, Urawa, Mr. Eido Shibamura;
- Plasma Physics Laboratory, Institute of Physical and Chemical Research, Wako, Dr. Toshihiko Dote;
- Radiation Laboratory, Institute of Physical and Chemical Research, Wako, Dr. Tan Takahashi;
- Department of Physics, Rikkyo University, Tokyo, Professor Iwao Ogawa;
- Department of Physics, Tokyo Metropolitan University, Tokyo, Professor Yozaburo Kaneko;
- Department of Chemistry, Tokyo Institute of Technology, Tokyo, Professor Yoshihiko Hatano;
- Department of Electrical Engineering, Keio Univeristy, Yokohama, Professor Tameyoshi Mori, Dr. Yoshiharu Nakamura;
- Reseasrch Information Center, Institute of Plasma Physics, Nagoya University, Nagoya, Professor Yukikazu Ichikawa;
- Department of Fine Measurements, Nagoya Institute of Technology, Nagoya, Professor Makoto Hayashi;
- Department of Engineering Science, Faculty of Engineering, Kyoto University, Kyoto, Professor Kuniya Fukuda;
- Department of Electronic Engineering, Technical College of Tokushima University, Tokushima, Professor Nobuaki Ikuta;
- Department of Electrical Engineering, Anan Technical College, Anan, Professor Keiichi Kondo; and
- Department of Electrical Engineering, Chiba Institute of Technology, Chiba, Dr. Haruo Itoh.

A progress report, "Advances in Swarm Experiments in Japan," was issued by the Research Group on Refinement and Extension of Swarm Experiments in March, 1979. This 36-page report in English, which may be obtained by writing to Professor Ogawa, gives abstracts of work being carried out at various laboratories. Furthermore, an international seminar on "Swarm Experiments in Atomic Collisions Research" was held in September, 1979, at Rikkyo University, Tokyo.* This international seminar, which I attended, indicates the

*ONR/Tokyo Scientific Bulletin Volume 4, Number 3, pp. 7 and 8.

recent upsurge in swarm experiment activity in Japan.[1] Every two months, the workers in this field get together for informal discussions (in Japanese, of course) for a day and a half. I attended the one held in December, 1979, at the Nagoya Institute of Technology in Nagoya. The next one was held at Hokkaido University in Sapporo at the end of January, 1980. Twenty-two contributed papers, out of some 1900, in electrical discharges were presented at the branch-session meeting of the Physical Society of Japan in October, 1979. An all-day symposium (in Japanese) on "Fundamental Processes of Electrical Discharges in Notrogen," which I attended, was held at the March, 1980, meeting of the Physical Society of Japan in Tokyo. The titles (translated from the Japanese) and authors of the papers at this symposium are given in Appendix 1. I have visited six of the institutions in Japan where swarm experiment work is being carried out. Some of this work will now be discussed.

GASEOUS ELECTRONICS AT HOKKAIDO UNIVERSITY[2]

Swarm research is being carried out at Hokkaido University in the laboratories of Professor Hiroaki Tagashira and Professor Saburo Sakamoto in the Department of Electrical Engineering, Faculty of Engineering. Tagashira and Sakamoto have been connected professionally for almost 20 years and there are many joint publications from the two laboratories. Sakamoto retires this year at the mandatory retirement age of 63 from Hokkaido University and has accepted a two-year appointment at Akita University, another national university. (The outstanding national universities in Japan have mandatory retirement at 63, except for Tokyo University where it is 60. Professors often accept appointments at other national universities where the retirement age is higher, or at private universities or in industry.) Tagashira, who is also with the Energy Conversion Research Institute of Hokkaido University, received his graduate training at the University of Liverpool with J. Lucas, although he had already published papers in gaseous electronics before going to Liverpool. Tagashira published a paper in Japan in 1963 entitled "Percentage Breakdown Characteristics of Electric Spark of Parallel Plane Gap and Sphere Gap." This was a theoretical paper and a theoretical-computational emphasis permeates his work today. His studies at Liverpool resulted in two theoretical and one experimental publications:

- "The Statistics of the Development of Ionization Currents in Electro-negative Gases" (1965),
- "A Consideration of the Statistics of the Photon Secondary Effect at the Cathode" (1966), and
- "The Measurement of Ionization Coefficients in Hydrogen and Nitrogen," (with J. Lucas) (1969).

Tagashira spent four months, in 1979, at the Hahn-Meitner-Institut fur Kernforschung in Berlin and will be a visitor for an extended period, in 1980, at the Ion Diffusion Unit, Research School of Physical Science, The Australian National University in Canberra (R. N. Crompton). Tagashira prefers to publish in British journals as he feels the time for reviews in Japan are excessively and unnecessarily long.

Tagashira's group consists of Assistant Professor Hideki Hasegawa, who works in semiconductors (this work will not be discussed), two research associates, and two technicians. This is the koza (chair) system used in leading Japanese universities and much longed for by faculty members in less prestigious institutions. In this system, every chair has associated with it an assistant professor, one or more research associates, and several technicians. At the present time, there are three research students enrolled in the doctor's program and four in the master's course in Tagashira's laboratory.

Sakamoto's background is in high-voltage engineering. He showed me his notebooks of laboriously copied American papers of thirty years ago; he has a complete knowledge of electrical breakdown work carried out outside Japan. When I visited Sapporo, Sakamoto had just returned from the United States, where he attended a conference on Electrical Insulation and Dielectric Phenomena held in the Poconos as well as the U.S.-Japanese Seminar on Electrical Conduction and Breakdown in Dielectrics held in October/November, 1979, at the University of Florida in Gainesville. Sakamoto's laboratory includes Assistant Professor Yohsuke Sakai and Dr. N. Sato.

The following gaseous electronics projects are now being worked on in Tagashira's laboratory:

1. computer simulation of electron avalanches in gases,
2. Boltzmann equation analysis of electron avalanches in gases,
3. computer simulation of electrical breakdown processes in gases,
4. measurement of ionization coefficients in gases, and
5. experimental investigation into electrical breakdown processes in gases.

The work in Tagashira's laboratory, along with that part of work in Sakamoto's laboratory which overlaps, is now discussed.

BOLTZMANN EQUATION

Since 1977, a considerable number of papers using the Boltzmann equation has been published by these two groups. The Boltzmann equation is an integral equation for the velocity distribution function of the particles of a gas. It is essentially a statement of the conservation of particles in geometrical and velocity space which takes the effect of collisions into account. It was first applied by Boltzmann to unionized gases. In swarm experiments, electrons are an important component of the gas, and the effect of electron collisions with gas molecules and the effect of the externally-applied electric field on the electrons must be taken into account. Coulomb interactions are neglected because of the weakly ionized aspect of swarm experiments. Once the distribution function for electrons is obtained, all the transport properties of electrons in the gas can be calculated. Collision cross sections must be inserted in the equation for those processes which are believed to occur. The application of the Boltzmann equation to weakly ionized gases in electric fields requires the knowledge of collision cross sections as a function of energy, for both elastic and inelastic processes (if inelastic processes occur). Such quantities as momentum transfer, excitation, attachment, and ionization cross-sections from experimental or theoretical work are inserted into the equation in order to calculate the electron energy distribution function. Usually, the distribution function is expanded in terms of spherical harmonics in velocity space with only the first two terms being retained. Recently, there has been work carried out in a number of countries, including Japan, to analyze the accuracy of the two-term expansion. The most recent work at Hokkaido on the Boltzmann equation involved a solution of the exact Boltzmann equation for argon by two different methods, with a comparison of the results obtained by the two-term expansion. Actually, the work involved exact solutions of the Boltzmann equation in argon by two different methods for three values of the ratio of electric field strength to neutral gas particle density (E/N) of 141, 283 and 566 Td (Td is the Townsend, after J. S. Townsend; it is equivalent to 0.354 V cm^{-1} $Torr^{-1}$ at 0 °C). In one of the methods, a Fourier expansion of the distribution function for electrons previously developed at Hokkaido (1978) was used, while, in the other, a direct estimation of moments of the electron density distribution in real space was made. Both methods gave the same results for electron swarm parameters. The swarm parameters obtained by the two-term expansion are generally in good agreement with those obtained by the exact methods except for the longitudinal diffusion coefficient, a high-order diffusion coefficient at E/N = 566 Td, and the transverse diffusion coefficient at all the E/N studied, suggesting that the disagreement between the longitudinal diffusion coefficients is due to a breakdown in the two-term expansion at high E/N; but that the disagreement between the transverse diffusion coefficients is due to a more essential difficulty in the two-term expansion. In general, the two-term expansion seems to be pretty good, except possibly when the excitation cross-sections are greater than the elastic cross-sections. Values of electron drift velocities, first Townsend coefficients, and average electron energies are given along with many other swarm parameters. There is no comparison made with experimental data.

In 1979, electron swarm parameters in CO_2 gas laser mixtures were analyzed for a range of E/N from 2.83 to 283 Td by a Boltzmann equation method in which the effect of electron impact ionization and attachment is taken into account. Gas mixtures of CO_2, N_2, and He with various concentration ratios were studied. The cross-sections were obtained from a variety of experimental measurements, both direct and indirect. The results showed that the calculated values of the ionizaiton coefficient and of the ratio of electron diffusion coefficient to mobility are in good agreement with the experimental values of these quantities. A similar calculation was made for SF_6 with good agreement with experimental results. Values of ionization coefficients, vibrational, and electronic excitation coefficients as well as attachment coefficients, electron drift velocities, electron diffusion coefficients, and mean electron energies are given as a function of E/N from 45 to 600 Td. A similar calculation

was made for N_2 for values of E/N from 56 to 1130 Td. The Boltzmann equation has also been applied by this group to the calculation of the three-body attachment coefficient in oxygen.

Monte Carlo simulation techniques have been developed for electron avalanches in argon and for the reaction and transport of O^- and O_2^- in oxygen. Monte Carlo simulation techniques, as we will learn, are being developed extensively at the Nagoya Institute of Technology. In principle, Monte Carlo simulation techniques are much simpler than the Boltzmann equation analysis. However, Monte Carlo techniques require much more computer time, but are very useful in studying transient phenomena, i.e., the devleopment in time of the electron distribution function.

EXPERIMENTAL WORK IN TAGASHIRA'S LABORATORY

The laboratory is involved in measuring the first and second Townsend coefficients in a variety of gases such as SF_6, H_2, N_2, He, air, and N_2 with 10% CH_4 added. In these experiments, the diameter of the electrodes is 15 cm and the electrode separation ranges up to 3 cm. The electrodes are gold plated and have Harrison profiles. A quartz plate was embedded in the middle of the cathode and a 500Å gold film was deposited on the quartz surface facing the discharge region. Ultraviolet light, incident on the rear of the cathode, penetrates the quartz and emits photoelectrons from the gold film into the discharge region. The electrode system is in a glass chamber of 40 cm diameter. The chamber is not baked out, but is evacuated to 2×10^{-6} Torr or less. D. C. voltages up to 10,000 volts are provided by a John Fluke supply, and a Takeda Riken vibrating reed electrometer is used to measure currents from 10^{-13} to 10^{-9} amperes. Sparking potentials are not measured and sparks are not allowed to occur, except for the studies carried out in SF_6. Measurements of pre-breakdown ionization currents have been published for H_2 and for SF_6–N_2 mixtures. Pre-breakdown currents in H_2 were measured for $76 < E/N < 576$ Td and were analyzed by both the classical Townsend equation and by the Lucas equation. The Lucas equation allows for the effect of variation, with electrode separation, of the geometric factor for photon secondary action at the cathode. The results suggest that the current growth for $E/N < 310$ Td, where the photon and positive ion secondary actions are appreciable, is represented better by the Lucas equation than by the classical Townsend equation. At higher E/N, the current growth is equally well represented by both equations because secondary emission by positive ions prevails over photoelectric emission. The values of the first Townsend coefficient were found to lie among the lowest of earlier measurements. (The first Townsend coefficients in hydrogen have been measured for at least 60 years.) The second Townsend coefficient in H_2 associated with photons was found to decrease with increasing E/N and shows a pressure dependence. The second Townsend coefficient associated with positive ions was found to increase rapidly at around 100 Td and remains almost independent of E/N until it starts to rise at about 280 Td. The Lucas equation is required to correct for the effect of electrode separation on the incidence of photons on the cathode. (If the first Townsend coefficient had been measured at constant electrode separation but with varying pressure, instead of with constant pressure and varying electrode separation, the Lucas equation would not be required. The second Townsend coefficient might be found to vary with electrode separation as well as with E/N.) The experiments in SF_6–N_2 mixtures gave the effective first Townsend coefficients, i.e., the true first Townsend coefficient minus the attachment coefficient for E/N values from 200 to 450 Td. Breakdown potentials were measured for products of pressure and electrode separation from 8 to 130 Torr cm.

RESEARCH IN SAKAMOTO'S LABORATORY

Experiments have been carried out on the breakdown of gases below the conventional breakdown potential by providing intense ionizaiton. Studies have been carried out in which breakdown in air between parallel electrodes separated by 1.0 cm occurs below the usual breakdown potential because of the irradiation of the gap by means of an ultraviolet flash of 10 ns duration on the cathode of 3317 Å radiation from a N_2 laser through holes in the anode. It is estimated that such a flash releases 10^9 electrons from the cathode. The experiments were carried out at 20 and 200 Torr. The discharge current was measured and factors affecting the current growth were investigated by comparing the experimental current with a computer-simulated current. The spatiotemporal development of the electron, positive ion, and negative ion densities and of the electric field was also calculated. It was found that at 200 Torr, with E/N between 121 and 130 Td, the electrons produced in the

gas by electron detachment have a large effect on the process of space charge accumulation, while the cathode photoemission effect is the main secondary process contributing to the space charge accumulation and breakdown at 20 Torr for E/N between 214 and 237. The breakdowns occurred at undervoltages up to 10%. Similar experiments are being carried out in SF_6, N_2, and mixtures of SF_6 and N_2 at 100 Torr.

Another experiment on breakdown below the conventional sparking potential was carried out in nitrogen in order to determine the effect of negative ions on the breakdown process in air, since nitrogen does not form negative ions. It was found that the development of the discharge in air is suppressed by the attachment of electrons, but that the electrons detached from the negative ions contribute to space charge accumulation and decrease the formative time lag of breakdown. The effect of negative ions on the breakdown process in air was also investigated by comparing computer-simulated transient discharges in air and nitrogen. The calculated currents are in good agreement with the experimentally observed current growths. The formation and accumulation of negative ions are found to be much smaller than that of positive ions throughout the gap, so that the electric fields are not greatly influenced by negative ions. However, the attachment process was found to decrease the ionization amplification of the gap.

Experiments are under way to try to make CO_2 lasers stable. It is desired to make a uniform, high-density, stable glow discharge in laser mixtures of CO_2, N_2, and He. The discharge phenomena are being observed with the aid of an image converter and image intensifier.

Another study in progress involves the firings and misfirings of spark plugs as a function of fuel mixture ratio of n-pentane and air at a pressure of 5 atmospheres. A voltage of about 20 Kv is applied to the spark gaps with no external ionization being provided. The diameter of the electrodes is 2 mm and gap separations vary from 0.7 to 1.2 mm. The effects of two kinds of discharges with equal energy are being compared, a "capacitive" discharge with 80 amperes peak current lasting for 50 ns and an "inductive" discharge with a current of a few milliamperes with a duration of a few milliseconds. Many gap configurations are being studied, including a triggered spark gap. This seems to have favorable properties but is very difficult to use in practice.

Discharge phenomena in liquids are also being studied. Pre-breakdown discharges in liquid nitrogen are being observed by Schlieren techniques. A point-to-plane electrode configuration with an electrode seperation from 1 to 3 mm is being used with voltages from 18 to 22 Kv. Both polarities are being studied. High-speed photographic studies using an image converter camera, an image intensifier, and a Schlieren system are being used to study the electrical breakdown process when a voltage pulse is applied to such a needle-plane gap immersed in dielectric liquids such as n-hexane, benzene, insulating oil, carbon tetrachloride, water, toluene, monochlorobenzene, n-alkenes, cyclohexane, toluene, dodecylbenzene, and iodobenzene. Measurements are made of the velocity with which luminosity propagates across the gap and the shock wave velocity is measured by means of Schlieren techniques. Experiments are also carried out to measure negative ion mobilities in liquids. In these studies the electrons are introduced into the liquid by applying a negative voltage to a razor blade immersed in the liquid. Electrons are released by field emission. The negative charges are passed through a mesh so that they enter a uniform field so that drift velocities can be measured. In these experiments, movement of the liquid occurs because of electrostatic forces, and these liquid movements affect the motion of the ions. The liquid velocity is being measured by a laser doppler method. The velocity of the liquid and of the ions is of the same order, about 10^{-4} cm^2/sec-volt. The true ion drift velocity is the difference of the measured ion velocity and the liquid velocity.

A 120-Kv impulse generator exists in the laboratory but is not being used. There is also a 1.2-Mev impulse Marx generator which has been used in the past to study the effect of snow on insulators. At present, the insulation only allows a voltage of 800 Kv to be used. There are no plans for carrying out research with this equipment. If these two generators were to be used, it would interfere with the very accurate measurement of small currents in the Townsend experiments.

GASEOUS ELECTRONICS AT THE UNIVERSITY OF TOKUSHIMA[3]

Professor Nobuaki Ikuta[4] and about five graduate students are carrying out a very active program in gaseous electronics at the University of Tokushima. Actually, Professor Ikuta is on the faculty of the Technical College of the University of Tokushima and holds a lectureship in the University of Tokushima.[5] (For a discussion of Technical Colleges in Japan, see reference 6). At the time of my visit, Professor Ikuta was the only senior worker in the group, but it was hoped that a Ph.D. from Hokkaido University would be available starting in April of 1980. Last year, Professor Ikuta was able to purchase $100,000 worth of equipment from a grant provided by the Special Equipment Foundation of the Ministry of Education.* The projects under way in Professor Ikuta's laboratory will now be described.

- An extensive spectroscopic study of N_2 glow discharges is being undertaken. Among other parameters, it is desired to obtain the electron energy distribution, the electric field distribution, and the rotational temperatures of neutral N^2 and of N_2^+ in the glow discharge. The discharge passes between two electrodes of 80-mm diameter at an electrode separation of 20 mm at a pressure of 2 Torr. Detailed observations have been made at a voltage of 300 volts and for a current of 15 milliamperes. Radiation from a narrow moveable slit parallel to the plane of the electrodes is analyzed with a plane grating spectrometer scanning wavelengths between 2000 and 8000 Å. Thus, the spatial distribution of the emitted radiation is measured as a function of wavelength. I was shown radiation profiles of the spatial dependence of the (0–0) transition of the second positive band at 3370Å as well as the distribution of radiation from the same glow discharge from a first negative N_2^+ transition. The intensity distributions are quite different. It is very interesting that an anode glow is observed for the (0–0) transition in the second positive band, but no anode glow is observed for transitions in the first negative band. From the intensities of the positive and negative bands, and from appropriate cross-section data, the electric field as a function of position can be calculated; and the electron energy distribution can be estimated with the help of the Boltzmann equation. At present, the calculational work is being extended to include Monte Carlo simulation of the glow discharge in order to obtain an estimate of the electric field distribution in the discharge. (The Monte Carlo simulation method is being actively pursued in at least three laboratories, Hokkaido, Nagoya Institute of Technology, and Tokushima.) This will also, of course, give the space charge distribution as well. The spatial intensity distributions in the glow discharge have also been observed for the (1–0), (2–0), and (3–0) transitions in the second positive band. It is planned to add some H_2 to the N_2 glow discharge in order to measure the Stark broadening of Hα. In fact, extensive studies of Stark effects in glow discharges will be undertaken in the future. Although present observations are limited to 2000-8000 Å, plans are being made to extend the observations to both shorter and longer wavelengths. They are hoping to observe vibrationally-excited emission of CO in the presence of N_2 in the neighborhood of 20,000 Å. It is also planned that the effect of current on the spectroscopic distribution of radiation will be investigated. The discharge system is not a high-purity one, although an ultra-high vacuum system was purchased last year. Although there are facilities in the laboratory for measuring impurities by mass spectrometer, this has not been done. I have not yet found a laboratory in Japan which bakes out systems to a reasonably high temperature. With some of the modern stainless steel vacuum systems coupled with new and fast turbomolecular pumps, many people think that baking out is not necessary. It is my impression, however, that gaseous electronics workers in Japan do not use high-vacuum techniques at the present time.

- Work is being carried on to develop a tunnel diode emitter which will have a long life when used as a pulsed electron emitter in gaseous electronics studies. Conventional fabrication gives very short lifetimes when pulses of 30 microamperes/cm^2 are drawn because of the cracking of the insulating film. In the present work, gold is being used as a substrate in order to provide heat conduction.

- Work is continuing on time lag distributions of discharges in anode-stressed fields. The spark gap being studied consists of two hemispherical gaps 12.5 cm in diameter with a needle inserted into the anode.

*Graduate students are not compensated in any way. Such graduate work leads to a master's degree.

Studies on this gap configuration have been going on in Japan for over 35 years. In the present work, the distribution of time lags for electrical breakdown is being measured in molecular gases at atmospheric pressure. However, the time lags are not being measured from the time of application of the voltage; rather, a potential difference is applied to the electrodes, and the gap is then irradiated with ultraviolet light, and time lags are measured from the beginning of the application of the radiation. N_2 is the gas which is being studied at the present time. With a short needle, direct breakdown occurs; with a long needle, one obtains a corona discharge. These experiments are being carried out in a large metal tank 1 meter in diameter.

- An experiment to measure D/μ electrons, i.e., the ratio of diffusion coefficient to mobility, is under way. The classical Townsend technique is being used except that the receiver electrode for measuring the electrons consists of 15 segments. The apparatus can be baked out to 130°C and "O rings" are being used. The apparatus can be evacuated to 2×10^{-8} Torr by means of a molecular pump.

- A new apparatus is being planned to detect photons in Townsend discharges and to extract electrons through a hole in the anode. It is hoped to correlate measured number density of electrons as a function of time with measurements of photons. This will be an all-metal apparatus evacuated to 10^{-9} Torr.

- Spectacular results have been obtained in the study of Townsend ionization currents in N_2. These observations are believed to be due to metastable states. A detailed report of this work was given in one of the nine papers at the Physical Society of Japan symposium on N_2 discharges, held in March, 1980, mentioned earlier in this report. Results show that, if a steady voltage is applied to an electrode configuration containing N_2 under constant ultraviolet illumination, the Townsend ionization current increases with time for times of the order of an hour. Ikuta presented curves for such experiments for pressures of 1, 2, 3, and 5 Torr, with the 5 Torr pressure current increasing for the longest time of all. Curves of Townsend currents as a function of E/p are different for "virgin" N_2 and for N_2 through which a Townsend discharge had been passed, the current in the activated gas being much higher at large values of E/N, say 3000 Td and lower. The temperature of the walls affects the current observed, with wall temperatures of 78°C, 48°C, and 25°C, showing markedly different currents. If one introduces a periodic variation in the wall temperature, oscillations appear in the ionization current. The effect of having a wall or not having a wall was displayed on the temporal growth of the current, and the current without a wall was much larger than that with a wall for all times. Such data were displayed for a pressure of 0.5 Torr, an electrode separation of 1.1 cm, and a value of E/N of 1700 Td. It was found that O_2 quenches the current. Similar effects were observed by Kachickas and Fisher in uniform fields in 1952 and by Bornstein and Fisher in corona discharges in 1955. It is good to see the effect being pursued so actively.

GASEOUS ELECTRONICS AT ANAN TECHNICAL COLLEGE[6]

Keiichi Kondo is a young assistant professor at Anan Technical College who carries out research in gaseous electronics almost single-handedly. The few students who work in his small but well-equipped laboratory are the age of either college freshmen or sophomores. He is closely associated with Professor Ikuta of Tokushima University and they have published papers together; Kondo lives in Tokushima. He expects to receive his doctor's degree soon from Hokkaido University.[7] What Porfessor Kondo is accomplishing, in the environment of what is essentially a junior college, is truly remarkable and sets an example for those faculty members at four-year colleges and universities in the United States who say they cannot carry on research because of heavy teaching loads and absence of graduate students. Kondo is very active, very enthusiastic, and very capable.[8]

Kondo studies the repetitive phenomena which occur when d.c. voltages are applied to point-to-plane electrode configurations in a gas. He and Ikuta have published two papers on corona: "A Spectroscopic Study of Positive and Negative and Negative Coronas in N_2-O_2 Mixtures" and "Highly Resolved Observations of the Primary Emission in Atmospheric Positive-streamer Corona." At the present time, he is studying positive point-to-plane corona in dry air and in N_2-O_2 mixtures with a little CH_4 added. The CH_4 is added to absorb

ultraviolet light produced in the discharge and to reduce the secondary photoelectric emission at the cathode. The studies are being carried out at relatively high pressures, i.e., atmospheric and somewhat below for positive corona, but negative coronas have been studied down to 50 Torr and up to 200 Torr.

The experiments result in the distribution of a particular wavelength intensity as a function of position for various times. Thus, such quantities as propagation velocities of disturbances can be determined. The corona luminosity is collected by a concave mirror placed inside the discharge chamber and is focussed at the inlet slit of a JASCO (Japan Spectroscopic Co.) CT-100 spectrometer having 8 Å dispersion per mm. Both the gas discharge and the concave mirror (which is inside the chamber) can be moved axially and laterally. The emission can be determined with a 0.01 mm spatial resolution. The electrical signal from a current pulse is combined with the optical output to obtain the data. By using a time-to-amplitude converter and a constant fraction discriminator with delay line, the arrival time spectrum of monochromatic photon pulses is accumulated in a multi-channel analyzer. Results have been obtained for the emission in air of both the second positive (0–0) band of N_2 (337.1 nm) and the first negative (0–0) band of N_2^+ (391.4 nm). Kondo is trying to compare his results with those obtained in a transient glow discharge. He is studying the light intensity pattern assuming, that the secondary emission from the cathode is changing with time.

Kondo is now planning to set up swarm experiments to use time-of-flight methods to measure diffusion coefficient of electrons, drift velocity of electrons, and the product of the first Townsend coefficient and electron mobility, all on the same apparatus.

GASEOUS ELECTRONICS AT NAGOYA INSTITUTE OF TECHNOLOGY[9]

Professor Makoto Hayashi conducts gaseous electronics research at the Nagoya Institute of Technology in the Department of Fine Measurements. The Ministry of Education, at the time of this writing, had just approved a two-month visit by Hayashi to the United States. Professor M. A. Biondi of the University of Pittsburgh will act as his host. The visit will begin in the middle of September, 1980. Hayashi carries out his research with a few master's program students. His work falls into two principal categories:

- Measurement and analysis of Townsend ionization currents, with special emphasis on high E/N values, and
- Monte Carlo simulation calculations of electron swarm parameters.

At the present time, he is very much involved in the determination of Townsend's first ionization coefficient in hydrogen from E/N = 140 to 2800 Td. He finds a maximum in the curve at about E/N = 700 Td. At the present time, he is using the Townsend equation to analyze his ionization currents, but he will use the Lucas equation in the future as well. Hayashi is especially interested in the determination of Townsend ionization coefficients at high values of E/N, where the electrons take some appreciable distance, after being released from the cathode, before they get into a steady state energy distribution characteristic of the value of E/N. Druyvestyn and Penning, as long ago as 1940, discussed a correction to the Townsend equation for analyzing ionization currents to take into account that electrons must travel some distance before coming into a steady state. They assumed a distance d_o was necessary for the electrons to equilibrate. The lower the pressure at which the ionization currents are measured, the larger is d_o. At atmospheric pressure, the correction is negligible. Usually, d_o is obtained empirically from the ionization current data. However, Hayashi has been using a Monte Carlo simulation method to determine d_o. Druyvestyn and Penning's treatment is really too simple to describe the true physical situation. Inserting $d - d_o$ instead of d in the Townsend equation implies that, for $d < d_o$, no ionization is produced, and that, precipitously and exactly at d_o and for $d > d_o$, the electrons are in a steady state energy distribution and that electrons produce ionization characteristic of E/N. Obviously, no such sharp discontinuity occurs. Hayashi's Monte Carlo calculations show that the current, when plotted against electrode separation at constant E/N, is constant until a distance d_{oi} such that Ed_{oi} is the ionization potential of the gas molecules, and that there is a small transition region in which the logarithmic plot of the current versus distance is concave upwards, and then becomes linear. Hayashi redefines d_o as the value of d for which the extrapolated linearly-increasing curve intersects the extended horizontal curve corresponding to the constant current below

d_{oi}. He finds that the experimental data on the linearly-increasing logarithmic plot can be represented by inserting $d - 3d_o$, where this d_o is his value calculated by the Monte Carlo simulation method. The only problem is that, in order to use his expression, one cannot use the value of the current emitted (and not reflected) from the cathode as the initial current. The reason for this is that, while the electrons between d_{oi} and $3d_o$ are not in a steady state distribution, they still produce some ionization. It is the value of the initial current from the cathode amplified between d_{oi} and $3d_o$ which should be used as the initial current when inserting $d - 3d_o$ in the Townsend equation. Of course, Hayashi's calculations depend on the use of correct cross-sections and also on his assumption that the electrons are emitted from the cathode with zero energy. Up to now, people have forced the analysis of their data by using the simple-minded d_o correction. Hayashi's procedure is to determine the first and second Townsend coefficient from the linear part of the curve. He obtains an initial current by extrapolating this linear part of the curve to zero distance; this is not the true initial current from the cathode, but is some kind of fictitious and meaningless initial current. Data in this region of low d are not very plentiful, and it is not clear that Hayashi's treatment is any improvement over the usual approach. His calculations, however, are very interesting. He uses about 12 electronic cross-sections in his calculations, and about 1000 electrons in calculating the electron energy distribution. This is not always sufficient. However, the mean electron energy can be obtained by following the history of a single electron emitted from the cathode. For purposes of illustration we quote some results of Hayashi for his d_o in H_2. For E/N = 560 Td, he obtains a value of 0.24 cm for a pressure of 0.5 Torr. Hayashi has calculated values of d_o for N_2 and O_2 as well. In the case of N_2, he uses, in addition to the available momentum transfer cross sections, the experimental vibration excitation cross-sections of Schulz, and theoretical rotational excitation cross-sections since there are no experimental data available on the latter cross-sections. He may use as many as 20 electronic excitation cross sections in his N_2 calculations. He is now calculating values of d_o in O_2 including attachment. His first calculations of d_o were made in He because exact cross-sections are known, and the calculations are very simple because of the lack of rotational and vibrational levels. He has tried to calculate d_o in argon, but feels hampered by the lack of experimental excitation cross-sections. Once Hayashi obtains the distribution function, he not only calculates the first Townsend coefficient, and, in the case of O_2, the attachment coefficient, but he also calculates the steady state electron drift velocity as well as the lateral electron diffusion coefficient. He also calculates the backscattering coefficient of electrons from the cathode (often called back diffusion). The Monte Carlo method gives the electron drift velocity as a function of position from the cathode. The electron drift velocity is very small at the cathode, rises very rapidly in a distance about equal to (Hayashi's) d_o, then has a few oscillations, flattens out, and then takes a steep rise just in front of the cathode. This means that electrons are not being scattered backward by the anode in the same manner as they are scattered by the gas. The anode is a good absorber and a poor reflector, and, hence, the drift velocity near the anode is greater than in the body of the gas. Thus, the Monte Carlo method shows that not only is the electron energy distribution not in a steady state only near the cathode, it is also not in a steady state in the neighborhood of the anode. This non-equilibrium situation near the anode obtains within a distance of about d_o from the anode.

Hayashi's experimental equipment is fairly standard. He uses gold-plated stainless steel electrodes with 10 cm diameter, having Harrison profiles. They are in a stainless steel tank of 20 cm diameter and 50 cm length. He uses the same technique for producing photoelectrons from the cathode as is used in Tagashira's laboratory, namely, irradiation through a gold-plated quartz slab inserted in the anode. Gap lengths up to 2 cm can be obtained. Copper gaskets are used. The steel tank is heated to 150°C for one-two weeks and is evacuated by an ion pump down to 10^{-7} Torr.

GASEOUS ELECTRONICS AT THE TOKYO INSTITUTE OF TECHNOLOGY[10,11]

Professor Yoshihiko Hatano* carries out an extremely active research program in gaseous electronics within the Department of Chemistry of the Tokyo Institute of Technology. Hatano is also associated with KEK (Japan's National Laboratory for High Energy Physics)** and is a member of the advisory board of the "photon

*Hatano will be a guest of the Department of Physics at the University of Kaiserslautern, West Germany, during July-August, 1980.
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factory* being constructed under KEK's auspices at Tsukuba (Japan's new scientific city).[12] Three students are receiving doctor's degrees in Hatano's laboratory this year. Much of the work in Hatano's laboratory involves the use of a 600 keV Febetron, producing intense 3 nanosecond x-ray pulses in photolysis studies. A second identical Febetron is on order. We now discuss some of the gaseous electronics research in this laboratory.

- Three-body attachment of thermal electrons to O_2 in the pure gas well as in the presence of other gases are being studied by means of microwave techniques. A Febetron x-ray pulse ionizes the gas, the electrons thermalize, and the shift in resonant frequency of a microwave cavity containing the gas and electrons is measured to determine the electron density as a function of time. The two-body initial electron capture rate, to form a vibrationally-excited state of O_2^-, has been measured, and the lifetime of this state has been estimated. A large discrepancy of the three-body coefficient with O_2 as the third body exists between the results obtained in this laboratory and the results of others from swarm experiments carried out at higher pressures. This discrepancy has been ascribed by Hatano to electron attachment to pre-existing van der Waal's molecules at the higher pressures of the swarm experiments. Experiments have been carried out and are continuing on the effect of admixtures of other gases to study the three-body attachment coefficient as a function of the nature of the third body. About twenty such substances have been studied. These include C_2H_4, CO_2, NH_3, and a number of polar gases.

- De-excitation of excited rare gas atoms are also being studied by the pulse radiolysis method. However, in these studies, optical, rather than microwave, techniques are used. Some recently completed work involved the measurement of the time-resolved optical emission of N_2^+ ($B^2\Sigma_u^+ \rightarrow X^2\ \Sigma_g^+$), induced by the Penning ionization of N_2 by He (2^3S) when a mixture of He and N_2 is irradiated by a Febetron pulse. The work resulted in the measurement of the rate constant. The addition of other atoms or molecules to He–N_2 mixtures changes the decay rate of this emission and gives the rate constants for He(2^3D) de-excitation by these various other atoms or molecules. The most recent studies have been made with neon, and a student is receiving his doctor's degree this year on this work. In the case of the neon studies, not only is the emission of radiation being measured, but the absorption of the decaying plasma is also being studied by means of radiation from a xenon flash bulb with a 500-μs pulse width. Hatano states that de-excitation cross-sections of Ne had not been measured before this work. The work has resulted in the measurement of de-excitation rate constants of Ne($^3P_2$), Ne($^3P_0$), and Ne($^3P_1$). Other results include the observation of time-resolved optical emission of N_2 ($C^3\pi_u \rightarrow B^3\pi_g$ and $B^3\pi_g \rightarrow A^3\Sigma_u^+$) from Ar–$N_2$ mixtures which have yielded the de-excitation rate constant of Ar ($^3P_{0,2}$) by N_2, while that of H_2 ($a^3\Sigma_g^+ \rightarrow b^3\Sigma_u^+$) from Ar–$H_2$ mixtures has demonstrated an important role of highly excited argon atoms as a precursor of the above emission. Hatano is also interested in using this technique in the study of superelastic collisions, such as He(2^1S) + e $\rightarrow$ He(2^3S) + e, and the effect on this reaction of the addition of SF_6 which attaches free electrons. Thus, studies are being carried out in the three-component mixture N_2, He, and SF_6 to study this effect.

- Work in this laboratory has shown that high resolution optical spectroscopy can be a valuable tool in the study of translational spectroscopy. In conventional translational spectroscopy, only charged ions and metastables can be studied. The present technique involves the measurement of Doppler profiles of radiation emitted when a substance is irradiated with electrons. Recently, a study by Hatano's group has measured the Doppler profiles of Balmer-α emission produced by electron impact on gaseous H_2O and D_2O. The studies allowed the determination of the average kinetic energies of the resulting excited H(^3S) and D(^3S) atoms. This followed earlier studies in this laboratory on Balmer-α Doppler emission profiles when electrons bombard gaseous H_2, D_2, and some simple hydrocarbons. The present work with H_2O and D_2O was undertaken to study the dissociation process of a simple triatomic molecule with the hopes that it would serve as a model for the dissociation processes under electron bombardment of more complicated polyatomic molecules, as well as to determine the magnitude of the isotope effect. In these experiments, Balmer radiation was observed at right angles to the incident electron beam, and was measured as a function of incident electron beam, and was measured as a function of incident electron

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energy near and somewhat above the threshold energy by an etalon-grating monochromator with a high resolving power. Electron energies were varied from about 25 to 80 ev. The observations are dominated by the Doppler effect due to the kinetic energies of the excited H and D atoms. The distribution of the observed radiation is bimodal, and shows that there are two channels leading to dissociation.

- X-rays from the Febetron have also been used in this laboratory to study electron attachment, electron-ion recombination, and energy transfer in nonpolar organic liquids and solids. In such media, there is no intrinsic conductivity, and, in this sense, the experiments are related to gaseous electronics where the conductivity of the gas is also provided by external means. In these liquid and solid experiments, auxiliary electric fields of some 2000-10,000 volt/cm are used to impart drift motions to the charged carriers produced by the x-ray flash. The experiments allow the analysis of transient currents in terms of mobilities, recombination, and the trapping of electrons by impurities. The recombination can be distinguished from linear effects by changing the intensity of the incident x-rays. As an example of some results, we state that the electron mobility in solid neopentane decreases with increasing temperature, becomes less on melting, and remains independent of temperature in the liquid state, whereas, in the case of cyclohexane, the electron mobility remains almost independent of temperature up to the melting point, is larger in the liquid state, and increases with temperature sharply above the melting point.

There are a number of other optical studies involving chemistry which will not be discussed here.

SUMMARY

An overall picture of gaseous electronics research in Japan has been given. Detailed summaries have been given of such work at five institutions, two granting the doctor's degree, two granting only the master's degree, and one granting no collegiate degree at all. I am impressed with the extent and the vitality of gaseous electronics research in Japan. In the field of Townsend ionization coefficients, Japan probably has more work going on than any other country. Certainly, there is no such work going on, at the present time, in the United States. Gaseous electronics research in Japan of the kind described in this report is fairly recent. Many of the experiments are repetitions or extensions of previous work and, in some cases, represent very detailed studies. In some cases, the work is of a pioneer nature.

APPENDIX I

Titles and Authors of Papers Presented at the March 1980 Symposium of Physical Society of Japan

- "Some Problems of Electrical Discharge in N_2," H. Tagashira, Hokkaido University;
- "Basic Properties of N and N_2," K. Takayanagi, Tokyo University;
- "Atomic and Molecular Processes in Ionized Gases and N_2," Y. Hatano, Tokyo Institute of Technology;
- "Collision Cross Section Data of N_2 and its Problems," M. Hayashi, Nagoya Institute of Technology;
- "Measurements of Collision Cross Sections in N_2," H. Tanaka, Sophia University, Tokyo;
- "Study of Deexcitation Processes of Excited Rare Gases Using N_2," T. Ueno, J. Yokoyama, and Y. Hatano, Tokyo Institute of Technology;
- "Pink Afterglow in N_2," S. Teii and S. Matsumura, Musashi Institute of Technology;
- "Vacuum Ultraviolet Spectroscopy in N_2," M. Nakamura, Tsukuba University; and
- "Influence of Metastable Molecules in N_2 Gas Discharges," N. Ikuta and H. Itoh, Tokushima University.

In addition to the above symposium, 20 contributed papers in gaseous electronics were given at the March, 1980, meeting of the Physical Society of Japan. Their titles (translated from the Japanese) and authors are:

- "Expansion of Transport Equation. VI. Behavior of Ion Swarms," T. Dote, Institute of Physical and Chemical Research, and A. Shimada, Osaka University of Education;

- "Possibility of Analysis of Unbalanced Eelctron Swarm Formation by Means of a Time of Flight Experiment," K. Kondo, Anan Technical College, and N. Ikuta, Tokushima University;
- "PIG Electrical Discharges," K. Kageyama, Toshiba Research and Development Center;
- "Simulation of Electron Ion Transport Processes in High Pressure O_2 Gas," Y. Sakai and K. Temman, Hokkaido University;
- "Handling of Inert Gas Positive Column by Means of Two-Electron Thermal Distribution," T. Shimizu, Tokyo University of Agriculture and Technology;
- "Determination of Energy Distribution Function of Electron Swarms by Means of E. C. Method," T. Makabe and T. Mori, Keio University;
- "A Simulation of the Instability Development of TEA CO_2 Laser, III." S. Sato, T. Yamabe, and K. Horii, Nagoya Institute of Technology;
- "Electrical Conduction and Dielectric Breakdown of Cryogenic Fluids, V," K. Kaizaki, H. Fujii, K. Yoshino, and Y. Inuishi, Osaka Institute of Technology;
- "Electrical Conduction and Dielectric Breakdown of Cryogenic Fluids, V." Pressure Dependence of Dielectric Breakdown of Liquid Nitrogen," M. Shiroishi, H. Fujii, K. Yoshino, and Y. Inuishi, Osaka Institute of Technology;
- "Blowout Phenomena of Metal Wire Explosion," K. Yukimura and M. Motoki, Doshisha University;
- "Measurement of Semi-stabilized Atomic Density in Ne–Ar Mixture Positive Column," N. Maruyama, Y. Ichikawa, and S. Tsutsui, Masashi Institute of Technology;
- "Specturm from Xe–O_2 Electrical Discharge Mixtures," M. Yamagishi, Tottori University of Education;
- "Effective Life of $A^3\Sigma_u^+$ State in N_2 Gas," K. Kendo, Miyakonojo Technical College, and N. Ikuta, Tokushima University;
- "Ionization Currents in N_2 Gas, VI. Influence of Contamination," H. Ito, Chiba Institute of Technology, and N. Ikuta, Tokushima University;
- "A Study of Argon Afterglow," T. Okada, K. Fukase, M. Matsunami, S. Koshizuka, and K. Motohashi, Gunma University, and Y. Kobayashi, Gunma Technical College;
- "Measurement of Recombination Coefficients by Means of Coaxial Cylindrical Diffusing Plasma, IV." K. Hashimoto, A. Matsumura, and N. Tsutsui, Musashi Institute of Technology;
- "Measurement of Electron Detachment Coefficient of SF_6 Gas," M. Shimazuma, Y. Sakai, H. Tagashira, Hokkaido University, and H. Hasegawa, Tomakomai Technical College;
- "An Experiment on the Hollow Cathode Arc Discharge," M. Hashida and S. Hashiguchi, Kyoto Institute of Technology;
- "Magnetically Driven High Amplitude Plasma Arc," K. Takeda, Japan Steel Basic Research Institute; and
- "Voltage Response of Transient Argon Arc with Step Increase in Current," H. Shindo, S. Imazu, Hiroshima University, and T. Inaba, Central Research Institute of Electric Power Industry.

APPENDIX II

Reference Notes

1. Unfortunately, the only Japanese scientist to attend the first Gaseous Electronics Meeting held in Sydney, Australia, in February, 1980, was an atomic physicist and not a gaseous electronics scientist. Funds for travel to meetings in foreign countries are very difficult for Japanese workers to obtain and may involve some political overtones. Two prominent Japanese researchers in gaseous electronics told me that they had paid their own way to attend the International Conference on Phenomena in Ionized Gases held in Grenoble in July, 1979.

2. Hokkaido University is located in the city of Sapporo (population 1,095,000) on the island of Hoddaido, the most northerly of the Japanese islands. Hokkaido contains 22% of Japan's area, but only 5% of its population. Hokkaido University is one of the national universities, i.e., all of whose expenses are paid by the Japanese government. The origin of the university can be traced back to the establishment of the Hokkaido Development Office Temporary School, which was founded in 1872 in Tokyo for the purpose of training pioneers to open up and develop Hokkaido. The school was moved to the small village of Sapporo in 1875 and was renamed Sapporo Agricultural College in 1876. Japan invited Dr. William Smith Clark of Massachusetts to help organize the college,

and he served as the first vice-president. Clark, a botanist, taught at Amherst and was president of Massachusetts Agricultural College. Although he stayed in Sapporo for only one year, he left a lasting impression. A bust of him was unveiled on the campus in 1926, and the Clark Memorial Student Center was inaugurated in 1960. In fact, Sapporo is, in many ways, an American-like city with wide tree-lined boulevards intersecting at right angles, and with streets designated as South 1st, North 3rd, East 2nd, etc. In 1907, the Sapporo Agricultural College became a part of the newly-established Tohoku Imperial University in Sendai on the island of Honshu. (All Japanese universities were founded after 1869). In 1918, the Hokkaido Imperial University was established in Sapporo, and the Sapporo Agricultural College was transferred to the new university. Faculties of Engineering and Science were added in 1924 and 1947, respectively. In 1947, along with the renaming of all "Imperial" universities in Japan, Hokkaido Imperial University became Hokkaido University. Graduate Schools of Science and Engineering were established in 1953.

Hokkaido University is one of 11 national universities which grant doctor's degrees in engineering and science. The others are:

- Kyushu University,
- University of Tokyo,
- Kyoto University,
- Tohoku University,
- Osaka University,
- Nagoya University,
- Hiroshima University (only recently allowed to grant doctor's degrees),
- Kobe University,
- Shizuoka University, and
- Tokyo Institute of Technology.

Kobe and Shizuoka Universities grant very few doctor's degrees. The above universities grant perhaps 80% of all the doctor's degrees in science and engineering in Japan. This is interesting in view of the fact that there are 78 national universities, 33 local public universities, and 299 private universities in Japan. It is further interesting to note that, in Japan, only 25% of students are enrolled in publicly supported universities.

The Faculty of Engineering of Hokkaido University consists of fourteen departments and ten chairs of applied science. The departments are:

- Civil Engineering,
- Architecture,
- Sanitary Engineering,
- Resources Development Engineering,
- Metallurgical Engineering,
- Mechanical Engineering (two departments),
- Precision Engineering,
- Electrical Engineering,
- Electronic Engineering,
- Applied Chemistry,
- Chemical Process Engineering,
- Applied Physics, and
- Nuclear Engineering.

The Graduate School of Engineering consists of 14 divisions with the same titles as above and one additional division, that of Information Engineering.

The ten chairs of Engineering Science are:

a. Engineering Physics,
b. Engineering Mathematics
c. and d. Engineering Mechanics (two chairs),
e. Engineering Science,
f. General Electrical Engineering,
g. and h. Physical Chemistry, and
i. and j. Analytical Chemistry (two chairs each).

The Faculty of Engineering also contains three institutes:

- Metals Research Institute (established 1958),
- Coal Research Institute (established 1975), and
- Energy Conversion Research Institute (established 1975).

The Faculty of Science consists of the following Departments:

- Mathematics,
- Physics,
- Chemistry (two departments),
- Geology and Mineralogy,
- Biology,
- Geophysics, and
- Polymer Science.

The Graduate School of Science contains the following Divisions:

- Botany,
- Zoology,
- Geophysics,
- Polymer Science, and
- Chemistry.

In addition, the Faculty of Science contains the following organizations:

- Akkeshi Marine Biological Station (established 1931),
- Institute of Algological Research (established 1933),
- Urakawa Seismological Observatory (established 1966),
- Chromosome Research Unit (established 1969),
- Erimo Geodetic Observatory (established 1970),
- Sapporo Seismological Observatory (established 1973),
- Research Center for Earthquake Prediction (established 1976), and
- Usu Volcano Observatory (established 1977).

The following organizations exist within the university and report directly to the administration:

- The Institute of Low Temperature Science (established 1941),
  a. Sea Ice Research Laboratory (established 1965),
  b. Avalanche Research Station,
  c. Frost Heaving Station, and
  d. Snowmelt Research Station,
- Research Institute of Applied Electricity (established 1943),
  a. Development Laboratory for Applied Eelctronic Measurement (established 1973),
- Research Institute for Catalysis (established 1943),

- Research Institute of Immunological Science (established 1950),
  a. Laboratory of Animal Experiment (established 1976),
- Central Institute of Isotope Science (established 1978), and
- Computing Center (established 1970).

The number of faculty (professors, assistant professors, and lecturers) in the various scientific and technical organizations of the university, as of May 1978, were as follows:

– Faculty of Science	166
– Faculty of Engineering	218
– Institute of Low Temperature Science	25
– Research Institute of Applied Electricity	28
– Research Institute for Catalysis	11
– Research Institute of Immunological Science	9
– Central Institute of Isotope Science	1
– Computing Center	1

As of May, 1978, there were 12,291 students enrolled in the university. Of these, 1,038 were in science and 2,068 in engineering. Science had 518 undergraduates and engineering had 1391 undergraduates. There were 191 master's course students in science and 458 in engineering. Science had 228 doctor's course students while engineering had 141. The balance of students were unspecified as to course pursuit. As of June 1977, there were only 47 foreign students enrolled in the university.

In 1972, Hokkaido University entered into a sister-university relationship with Portland State University, and, in 1976, it entered into a similar relationship with the University of Massachusetts.

3. The University of Tokushima is located in the city of Tokushima on the island of Shikoku. The university was established in 1949, although the Faculty of Engineering belonged to another higher educational institution which was absorbed by the new university. Graduate studies in engineering, leading to a master's degree, were added in the 1960s. No doctor's degrees are granted by the university. There is no faculty of science. The following departments are in the Faculty of Engineering:

- Civil Engineering,
- Construction Engineering,
- Mechanical Engineering,
- Precision Mechanics,
- Applied Chemsitry,
- Chemical Engineering,
- Electrical Engineering,
- Electronic Engineering,
- Information Science and Systems Engineering, and
- Applied Physical Science.

The Department of Applied Physical Science seems to be a service department, including the subjects of applied physics, applied mathematics, and data processing engineering. No students are enrolled in the department. Every department, except Applied Physical Science, has a program leading to the master's degree.

As of 1978, the university had an enrollment of 4,580, with 4,100 in the undergraduate programs and the rest in graduate programs. Of these students, 1500 were undergraduate students in engineering and 148 were pursuing the master's course in engineering.

As will be discussed in Reference Note 4, there is a technical college associated with Tokushima University. There are 720 students enrolled in the technical college.

4. Professor Ikuta did his undergraduate work at the University of Tokushima and took his doctor's degree at the University of Tokyo. I have found that many faculty members are teaching at the same university at which they did undergraduate work. Ikuta has just received an award from the Ministry of Education to spend three weeks in Australia, visiting gaseous electronics laboratories.

5. There are two engineering faculties at the University of Tokushima: the Faculty of Engineering and the College of Engineering. The Faculty of Engineering is primarily associated with the full-time, four-year day program, and the College of Engineering is primarily associated with the two-year technical college associated with the University of Tokushima. There is not a sharp distinction between the two faculties. In view of Professor Ikuta's active research, it is expected that he will be transferred to the Faculty of Engineering in the not-too-distant future.

6. Anan Technical College is located on the island of Shikoku, 20 miles south of Tokushima City. Like Tokushima, it is on the east coast of Shikoku. There are 52 national technical colleges in Japan, with a total enrollment of 37,000 students. Nine of the national technical colleges are associated with universities. There are also four public and seven private technical colleges, with a combined enrollment of some 11,000 students. Technical colleges provide training which extends for two years beyond high school and leads to no degree. However, most technical colleges are designed to accept students after graduation from junior high school and provide them with five years of education. There are also two-year technical colleges which accept students upon graduation from the traditional high school curriculum. On graduation from the five-year technical college, students may enroll in one of the two universities of science and technology in Japan, namely, Nagaoka University of Science and Technology and Toyohashi University of Science and Technology. These are four-year universities. There is no other path for entrance into these two universities except through the five-year technical college program. Thus students graduating from the two-year technical colleges are not allowed to enter these two universities. However, graduates of both the five-year and two-year technical colleges may enroll in traditional universities, but few do so. Actually, most graduates of technical colleges go right to work. At the technical college of the University of Tokushima, the courses are given at night because most students work full time, and it takes three years, instead of two, to complete the course of study. I was told that well-to-do families send their children through the traditional so-called 6-3-3-4 program leading to a conventional university education. Poorer families tend to send their children to the 6-3-5 sequence leading to graduation from a technical college. Students at technical colleges are high achievers. The technical colleges not associated with universities have very difficult entrance examinations. Three times as many students apply to these technical colleges as can be admitted. It is easy to enter technical colleges associated with universities, but it is difficult to stay in. Less than 1% of the students enter technical colleges at the end of junior high school; the rest go to conventional three-year high schools. The technical college system was ostensibly founded because of the needs of industry, but at least one informed person told me that it was also an attempt to keep some students from becoming rebels in the conventional universities. The nine technical colleges associated with universities take weak students, and in some people's opinions are not colleges at all. Such students could not be admitted to technical colleges such as Anan. One person's private opinion is that the only reason for the existence of these nine university-associated technical colleges is so that these universities can have more staff. Each technical college is quite small; perhaps the average institution has 800 students. Industries have a very high opinion of the graduates of technical colleges.

Each technical college has its own curriculum. The following information applies to Anan. Each student must specialize in one of the following areas:

- electrical engineering,
- mechanical engineering,
- civil engineering,
- applied chemistry,
- material engineering, or
- architecture.

Students at Anan must take:

- fundamental physics, 4 hours/week for 1 year,
- applied physics, 5 hours/week for 1 year,
- fundamental mathematics, average 3.6 hours/week for 5 years,
- applied mathematics, 4 hours/week for 1 year, and
- chemistry, 3 hours/week for 2 years.

In the electrical engineering option, for example, a student must take:

- information theory, 2 hours/week for 2 years,
- electromagnetic theory, 2 hours/week for 2 years,
- electric circuit theory, 2 hours/week for 3 years, and some additional applied mathematics.

Students at technical colleges take less history, less Japanese, and less social studies courses than students at conventional high schools. On the other hand, at Anan, they have more foreign language studies. English and German are both required at Anan. German is studied for 2 hours/week for 2 years, and English is studied in eight different courses for an average of about 4 hours/week for 5 years. Students at Anan have 36-38 contact hours a week in school spread over 5 1/2 days in contrast to the 16-18 hours/week contact in regular universities. The path through the technical colleges is designed for people who are going into industry; it is not intended for scientists and engineers. After three years at Anan, the students are free to take the university entrance examinations. They do very well in physics, mathematics, chemistry, and English, but not well in Japanese history and in social studies.

The students at the technical college at Tokushima University are, in general, older students who are working. About half of them are full-time factory workers and about a half have part-time jobs. A student who does well at the technical college of Tokushima University may transfer to the regular University of Tokushima engineering course, the so-called "Faculty of Engineering." A student who is not doing well in the Faculty of Engineering program may not, under any circumstances, transfer to the technical college program, which goes under the name of "College of Engineering."

7. There are two routes by which a doctor's degree may be obtained in any subject in Japan. One is the conventional method in which courses are taken and a thesis is written. The recipients of such degrees are called "course doctors." The other path is to be awarded a doctor's degree on the basis of published papers. Such recipients are called "paper doctors." The only examination a "paper doctor" candidate has to take is in foreign languages. There is no distinction in status between the two types of doctoral degrees. Usually three to five published papers are required to become a "paper doctor." About 70% of all "doctors" in Japan are course doctors. There are serious problems with the "paper" doctor program when there are co-authors on the papers. If the director of an industrial firm wishes to become a "paper" doctor, it may easily lead to "difficulties." Only those universities that grant course doctor degrees grant paper doctor degrees.

8. Kondo will attend the Institute of Electrical Engineers symposium on electrical breakdown in gases to be held in September, 1980, in Edinburgh.

9. The Nagoya Institute of Technology was established in May, 1949, as a national university, and was formed by merging the Nagoya College of Technology and the Aichi Prefectural College of Technology. The Nagoya College of Technology had been founded in March 1905 while the Aichi Prefectural College of Technology had been established in 1943. Since 1964, the Institute has been granting the master's degree. There are about 4500 students enrolled. Students may complete the undergraduate course in four years by taking classes during the day and in five years by taking courses in the evening. However, only about one quarter of the programs are available in the five-year evening program.

The following departments are in the day course undergraduate program:

- Civil Engineering,
- Architecture,
- Mechanical Engineering
- Industrial-mechanical Engineering,
- Electrical Engineering,
- Electronics,
- Fiber and Polymer Engineering,
- Industrial Chemistry,
- Synthetic Chemistry,
- Inorganic Materials,
- Metallurgical Engineering,
- Fine Measurements,
- Management Engineering, and
- Information Engineering.

In the evening undergraduate program, there are only four departments, civil engineering, mechanical engineering, electrical engineering, and industrial chemistry. There are graduate programs leading to the master's degree in all of the departments listed above except Information Engineering.

Of the 4500 students, 3200 are enrolled in the undergraduate day course, 1000 in the undergraduate evening course, and about 260 in the graduate course. Every department has a fixed number of openings which cannot be exceeded.

10. Tokyo Institute of Technology was established in 1881 and is a leading institution in the field of engineering and science in Japan. It has about 3300 undergraduate and about 1700 graduate students.

Although Tokyo Institute of Technology is one of the 11 national universities granting the doctor's degree, it does not have a koza (chair) system in which each koza has a professor, an associate or assistant professor or lecturer, two research associates and one technician all in the same field. However, a koza is sometimes introduced at Tokyo Institute of Technology for a special field. The koza system is slowly disappearing in physics and electrical engineering. However, there are huge kozas in certain technological fields such as the one on electrostatic precipitation at the University of Tokyo.

11. During my visit to Tokyo Institute of Technology, I met Dr. R. Norman Jones, a chemical spectroscopist retired from the National Research Council, Ottawa. He has an unusual two-year appointment at Tokyo Institute of Technology in which he is conducting seminars for graduate students in chemistry in English. Students are also asked to give short presentations in English. The aim is to get Japanese graduate students in chemistry to be able to communicate effectively in English on a scientific level. Jones prepares notes for his students in advance of the presentaiton. Professor Jones assigns projects and problems to students in groups of three. For one student to fail would be too difficult a situation for the student to handle. Jones has some previous history in Japan. He seems to be doing a very necessary job. Hopefully, his work is a precursor of other such activity in Japan. There are virtually no foreign faculty members in Japanese universities, and the situation is even more extreme in the high schools. Virtually all English in Japan is taught by Japanese. Students attend Professor Jones' seminars by their own choice; it is not a required course. Professor Jones told me that graduate students are only involved with their professors; graduate students in the same subject in the same university working with different professors do not even know each other. If a professor invites an outside speaker, usually only that professor's graduate students will attend.

12. This photon factory* will consist of a 2.5 GeV Linac and storage ring. The Linac should be completed very shortly. The storage ring will be constructed in Fiscal 1980 and various facilities, such as optical facilities and buildings for research, will be constructed in Fiscal 1981. The machine will be available for use from 1982 on.

*ONR Tokyo *Scientific Bulletin*, Vol. 3, No. 4, pp. 9-22.

The radiation will be available from 0.1Å up to infrared or microwave wavelengths. The device will have a maximum current intensity of 0.5 amp and will be one of the most intense sources of radiation in the world. It is expected that most of the time visible radiation will be used.

An advisory board has been set up to plan for studies in the following areas:

- X-ray diffraction and scattering including biological studies,
- spectroscopy in various wave length regions such as X-ray, vacuum ultraviolet, etc., including chemical analysis by using tunable X-rays,
- Radiation efects on matter including biological effects; X-ray diagnosis of human body, and
- Application to lithography and printed circuits.

APPENDIX III

Institutions Active in Swarm Experiments

Anan Technical College Department of Electrical Engineering Aoki, Minobayashi-cho Anan, Tokushima 774	Professor Keiichi Kondo
Chiba Institute of Technology Department of Electrical Engineering 2-17-1 Tsudanuma Narashino, Chiba 275	Dr. Haruo Itoh
Gunma University Department of Electrical Engineering 1-5-1 Tenjin-cho Kiryu, Gunma 376	Professor Minoru Sugawara
Hokkaido University Department of Electrical Engineering Sapporo 060	Professor Hiroaki Tagashira Professor Saburo Sakamoto
Ibaraki University Department of Electrical Engineering 4-12-1 Naka-Narusawa Hitachi 316	Professor Hiroshi Mase
The Institute of Physical and Chemical Research Plasma Physics Laboratory 2-1 Hirosawa Wako, Saitama 351	Dr. Toshihiko Dote
The Institute of Physical and Chemical Research Radiation Laboratory 2-1 Hirosawa Wako, Saitama 351	Dr. Tan Takahashi

Keio University Department of Electrical Engineering 3-14-1 Hiyoshi Kohoku-ku, Yokohama 223	Professor Tameyoshi Mori Dr. Yoshiharu Nakamura
Kyoto University Department of Electrical Engineering Faculty of Engineering Yoshida Honmachi Sakyo-ku, Kyoto 606	Professor Kuniya Fukuda
Nagoya Institute of Technology Department of Fine Measurements Okiso-cho, Showa-ku Nagoya 66	Dr. Makoto Hayashi
Nagoya University Research Information Center Furocho, Chikusa-ku Nagoya 464	Professor Yukikazu Ichikawa
Rikkyo University Department of Physics 3-34-1 Nishi-Ikebukuro Toshima-ku Tokyo 171	Professor Iwao Ogawa
Saitama Colelge of Health Department of Physics 519 Ozazu-Kamiokubo Urawa, Saitama 338	Mr. Eido Shibamura
Tohoku University Department of Nuclear Engineering Faculty of Engineering Aramaki, Sendai 980	Professor Kunio Seto Professor Masahiro Takebe
Tokyo Institute of Technology Department of Chemistry 2-12-1 Ookayama, Meguro-ku Tokyo 152	Professor Yoshihiko Hatano
Tokyo Metropolitan University Department of Physics 2-1-1 Fukuzawa Setagaya-ku Tokyo 158	Professor Yozaburo Kaneko
University of Tokushima Department of Electronic Engineering Technical College Tokushima 770	Professor Nobuaki Ikuta

INTERNATIONAL CONFERENCE ON PLASMA PHYSICS 1980, NAGOYA, JAPAN

Leon H. Fisher

A conference entitled "International Conference on Plasma Physics 1980" was held at the Nagoya Kanko Hotel in Nagoya,[1] Japan, from April 7 to 11, 1980. It was the first international conference of its kind, in the sense that it covered every aspect of plasma physics and, in my opinion, the conference was spectacularly successful. Japan is not a newcomer to the field of plasma physics; indeed, it has been and is one of the world's leaders in this field. In 1974, the "Conference on Plasma Physics and Controlled Nuclear Fusion Research" was held in Tokyo. This is an international conference held about every two years, and the first was held in 1961 in Salzburg. The present meeting was much broader in scope than these other meetings, and papers on large machines did not dominate the meeting.

INTRODUCTION TO PLASMA PHYSICS

This introduction is for those readers of the *Bulletin* who are not physicists, but who need to know or would like to know something about this important field. Experience has taught me that many well-educated scientists do not know what a physicist means by the term "plasma," and why such an extensive and world-wide effort is being made in this field. Hopefully, this introduction will help the uninitiated reader to get something out of the report. Many of the terms used in this introduction will be found throughout the report.

The field of plasma physics is now one of the most active in the entire field of physics. Basic studies in this field go back to the 1920s with the pioneering work of Langmuir, who introduced the term "plasma" into physics. At that time, and up to the beginning of the 1950s, the study of plasmas was a small part of the field of gaseous electronics. At the present time, plasma physics is a much larger field than that of gaseous electronics. This tremendous activity in plasma physics began suddenly in the early 1950s as a secret program in many countries in the hopes that the research would lead to a virtually unlimited source of energy.[2] In the United States, Project Sherwood was the code name for this work. The crash programs of the 1950s failed to produce an energy source. Difficulties were encountered that were far more serious than were first anticipated. This resulted in a world-wide declassification of the programs in the mid-1950s, and, since then, there has been increasing international cooperation in this field. All data are now open and freely shared, and international cooperative ventures have been and are being undertaken. This is a good example of how countries can unite to solve problems of mutual concern.

A plasma is generally defined to be an ionized gas in which the density of positive and negative charges (almost always electrons) are very closely equal. Langmuir studied plasmas in which only a small fraction of the atoms are ionized, and such gases are called weakly ionized plasmas. A fluorescent bulb and the ionosphere are examples of weakly ionized plasmas. In such plasmas, collisions of charged particles with neutral gas molecules are important.

The recent explosion in plasma physics involves completely ionized plasmas in which the collisions of charged particles with each other predominate over collisions with neutral particles. In such plasmas, all electrons may be removed from the nucleus. The sun and other stars constitute such completely ionized plasmas. Such plasmas are hot and dense. Interplanetary space contains some completely or almost completely ionized plasmas, which are low-density plasmas.

Plasma is sometimes called the fourth state of matter, and is undoubtedly the most common state of matter in the universe. Strong liquid electrolytes and metals may also be considered as high-density plasmas. In electrolytes and metals, the plasmas are stable because of quantum mechanical considerations; in stars, the dense plasmas are stable because of gravitational attraction. However, most of the man-made plasmas for energy purposes are unstable; neither gravitational forces nor quantum mechanical considerations apply, and this is the principal problem facing the plasma physics community.

In order to produce energy from plasmas, the nuclei of light atoms must get very close to each other to allow short-range attractive nuclear forces to operate. This means overcoming the Coulomb repulsion among nuclei, and the nuclei must have very high random energy, corresponding to temperatures of 10^8 °K and a product of ion density and confinement time of about 10^{15} sec cm^{-3}. The problem is to develop machines where plasmas of suitable density and temperature will be confined for long enough times to produce more energy than is expended.

The Sherwood and all other programs in the 1950s and 1960s used magnetic fields to try to contain low-density hot plasmas. This effort is still going on and was the principal subject of the present conference. However, with the invention of the laser, and the development of gigantic high-power pulsed lasers, another approach to energy production from plasmas has been getting tremendous amounts of attention. This is a scheme known as inertial confinement or inertial confinement fusion (ICF) and does not involve the use of magnetic field. Inertial confinement involves the focusing of many intense laser beams simultaneously at many different points of a small spherical pellet. This is an intense pulse of radiant energy lasting for perhaps 10^{-9} s. This compresses the material of the pellet, produces a high-density plasma, gives off x-rays, among other things, and hopefully produces a nuclear reaction. Although the bulk of the interest in the present conference was on confinement of low-density hot plasmas by magnetic fields, some attention was paid to inertial confinement by laser beams. Inertial confinement by intense electron or ion beam bombardment of pellets is also being pursued.

Magnetic confinement of low-density plasmas is carried out in four principal ways:

1. In the linear pinch, a huge current is caused to flow axially in a gas, either in a linear cylindrical container or in toroidal geometry. The plasma is formed by a discharge of a huge condenser bank, and the plasma is brought together toward the axis of the tube by the tremendous magnetic forces from the circular magnetic field generated by the current in the gas. Theta pinches have current flows from condenser banks to produce longitudinal magnetic fields.

2. In a mirror machine, a non-uniform magnetic field is set up, and a plasma is injected into the magnetic field. The non-uniform magnetic field acts as a mirror, so that charged particles have difficulty in leaving the configuration. This is an oversimplified statement of the operation of a mirror machine. Magnetic fields can be varied with time in a number of ways to create and to heat as well as to manipulate the plasma.

3. The stellarator is a machine that was developed at Princeton University in the 1950s. The word implies that stellar processes might be expected to occur in the machine. The stellarator started out as a complicated "figure 8" arrangement, but has now assumed a toroidal form. In the stellarator, the forces contributing to equilibrium are supplied by coils, and the stabilizing magnetic field is also supplied by coils.

4. The tokamak, a relatively recent Russian development, has the special feature that a transformer threads a torus such that the plasma ring inside it acts as a secondary winding. This transformer, when energized, produces a plasma current around the torus, the current heats the plasma ohmically, and also provides confinement of the plasma much as in the pinch. There is also a strong toroidal magnetic field produced by windings which tend to prevent certain instabilities.

Some machines can be used either as stellarators or tokamaks.

A plasma must be very hot to produce energy. In the pinch, heating is carried out by the current itself. In

other configurations, the plasma must be heated. In addition to ohmic heating, injection of high-energy neutral particles has been used. The particles can become ionized either by collisions in the plasma, or by so-called Lorentz forces due to the high velocity of the particles in a magnetic field. Heating can also occur by using some of the resonance frequencies present in a plasma. This is often called R. F. heating.

Langmuir showed that a plasma can oscillate. Also various kinds of waves can propagate through a plasma. Electromagnetic waves as well as mechanical waves are of interest. Since the earth has a magnetic field, and since plasma physics uses magnetic fields for confinement, the study of plasma oscillations and the propagation of electromagnetic waves in plasmas in the presence of magnetic fields are of great interest. The term magnetohydrodynamics (MHD) is used to describe collective plasma motions in the presence of magnetic fields. There are certain resonant plasma frequencies associated with the presence of magnetic fields such as the ion cyclotron and electron cyclotron frequencies.

The Q machine is a device which produces a low-energy quiescent plasma without the application of electric fields. The plasma is produced by allowing alkali atoms to impinge on a hot surface. Such machines have been used to study basic properties of plasmas.

Finally, one should introduce the word "diagnostics." In plasma physics, one wants to know the electron and ion density, and the electron and ion temperatures (usually much different from each other), among other things. Langmuir developed a probe which is a piece of metal inserted into the plasma. Currents drawn to the metal, when various potential differences are applied to it and other electrodes of the plasma give such information. However, many other diagnostic tools have been developed. These involve spectroscopy, lasers, and other techniques.

INTRODUCTION TO THE CONFERENCE

The genesis of the recent conference is complicated and interesting. The "International Conference on Plasma Physics 1980" was a joint meeting of the "Fourth Kiev International Conference on Plasma Theory" and the "Fourth International Congress on Waves and Instabilities in Plasmas." The three previous "Kiev International Conferences on Plasma Theory" were held in Kiev, U.S.S.R., in 1971 and in 1974, and in Trieste, Italy, in 1977. The three previous "International Congresses on Waves and Instabilities in Plasmas" were held in 1973 and in 1975 in Innsbruck, Austria, and in 1977 in Palaiseau, France.

The "International Congress on Waves and Instabilities in Plasmas," itself, has a somewhat complicated and interesting history. These conferences arose from two Q machine conferences, one held in Paris in 1969 to which 300 people came, and another held in 1971 in Røskilde, Denmark, at which only 80 people were present. It was decided to add waves and instabilities to the subject of the next conference in order to attract more attendees, and then, eventually, the Q machine aspect of the conference was dropped entirely, resulting in the first Innsbruck conference in 1973.

The present conference was organized by the Fusion Research Association of Japan[3] under the auspices of IUPUP (the International Union of Pure and Applied Physics). The conference was supported by URSI (Union Radio-Scientifique Internationale), the Science Council of Japan, and the Ministry of Education, Science, and Culture. Support was also provided by many Japanese companies.

The international organizing committee for the conference consisted of 40 members from 17 countries, and was headed by B. B. Kadomtsev of the Kurchatov Institute of Atomic Energy, Moscow, who also gave the opening technical paper. K. Takayama of Nagoya University was vice-chairman of the international organizing committee, as well as being chairman of the local organizing committee. The secretary general of the local organizing committee was Y. H. Ichikawa of the Institute of Plasma Physics[4], Nagoya University.

The scope of the conference was announced as covering almost all subjects in plasma physics. These include theory, computation and basic experiments on waves, instabilities, nonlinear phenomena, effects of

inhomogeneity, transport phenomena, particle acceleration, turbulence, coherence, and stochasticity; they also include plasma found in fusion devices, laboratory plasmas, and plasmas found in space. Experimental and diagnostic techniques were also included. Thus this conference included material which is generally covered in meetings of the America Geophysical Society.

There were some 550 attendees from 30 countries[5] distributed as follows: Australia 2, Austria 4, Belgium 3, Brazil 2, Bulgaria 1, Canada 5, China 3, Czechoslovakia 1, Denmark 3, France 22, Federal Republic of Germany 15, German Democratic Republic 1, India 9, Iran 1, Italy 10, Japan 347, The Netherlands 3, Norway 3, Pakistan 1, Poland 1, Portugal 1, South Africa 1, Sweden 5, Switzerland 2, Thailand[6] 1, United Kingdom 2, U.S.A. 64, U.S.S.R.[7] 32, and Yugoslavia 1.

Papers at the conference were of four types: general invited talks, invited talks on special topics, oral sessions, and poster sessions. The conference sessions opened each day with one general invited talk of forty minutes' duration in plenary session. The remainder of the mornings were devoted to invited papers on special topics in two parallel sessions. The oral session papers were presented in two parallel sessions in the afternoons. The distribution of talks by type follows: five general invited talks, 35 invited talks on special topics, 102 contributed papers presented in the oral sessions, and 319 poster session papers.

A 421-page bound volume entitled "Proceedings of International Conference on Plasma Physics, Volume 1," containing abstracts of the contributed papers, was distributed at the meeting. No abstracts or texts were available for either the general invited talks or the invited talks on special topics. Texts of these will be issued as Volume 2 of the "Proceedings . . . ," possibly in a few months.

GENERAL INVITED TALKS

The titles of the five general invited talks and authors follow:

- "Magnetic Confinement of Plasmas," B. B. Kodomtsev, I. V. Kurchatov Institute of Atomic Energy, Moscow, U.S.S.R.,
- "Problems on Space Plasmas," T. Obayashi, Institute of Space and Aeronautical Science, University of Tokyo (paper presented by A. Nishida of same institution),
- "Laboratory Plasma Physics," P. Michelsen, Risø National Laboratory, Røskilde, Denmark,
- "Astrophysical Plasma Physics," R. Pellat, Ecole Polytechnique, Palaiseau, France, and
- "High Energy Density Plasma Physics-Phenomena and Measurements-," M. J. Lubin, University of Rochester, Rochester, U.S.A.

I did not hear the talk by Pellat. Summaries of the other four talks now follow.

In his talk "Magnetic Confinement of Plasmas," Kadomtsev discussed the use of magnetic confinement for fusion purposes in tokamaks, stellarators, pinches and mirrors. He covered both theory and basic experiments. Of these four approaches to fusion, Kadomtsev believes that tokamaks embody the most advanced concepts. He discussed the parameters of the new generation of tokamaks now under construction. The U.S.S.R. machine may be postponed. The tokamak confinement principle is based on the Kruskal-Shafranow condition and on the equations covering plasmas. Plasma stability has been studied both from the experimental and theoretical side, and there is good agreement between theory and experiment. In existing tokamaks, the central core of the plasma is very hot, but the edge of the plasma is cold. The plasma edge interacts with the walls, and radiation by impurities released from the walls is serious. The transport phenomena were analyzed by Artsimovich in 1972. There are new detailed experimental and theoretical data on electron and ion transport. The ion transport is in accord with theoretical predictions within a factor of 2 or 3. The ion conductivity is described as classical or neoclassical (Galeev-Sageev). The electron thermal conductivity is anomalous.

He gave the proposed parameters of INTOR.[8] INTOR is to have a major radius of 5.2 meter, an average minor radius of 1.6 meters, a toroidal field of 5.5 Tesla, a plasma current of 6 megaamperes, an ion temperature

of 10 keV, an ion density of 1.4×10^{14} cm^3, a confinement time of about 1.4 seconds, and a β (ratio of plasma pressure to applied magnetic field pressure) of 5%. Kadomtsev feels that going ahead on this machine is a reasonable and desirable thing to do. He discussed Alcator scaling results in which confinement time is proportional to the cube of the radius. Kadomtsev says that there is a possibility that such a relationship exists, although Ogawa proposes a somewhat different dependence on radius. A great deal of information has been obtained recently, both experimental and theoretical, on the radiation leakage due to impurities. Sputtering (the removal of material from a solid by ion bombardment) at the walls is a very important channel of impurity production. The use of divertors (magnetic configurations which prevent impurities from reentering the active plasma) is probably going to be unavoidable in reactors. Divertors have been shown to be capable of reducing radiation by impurities. The region of stable operation where instabilities can be avoided at high density was discussed. The current disruptions in tokamaks discovered by Razumova were mentioned. The nature of internal disruption is now clear. The nonlinear interaction of various plasma modes with each other leads to MHD turbulence with magnetic field line reconnection.

Plasma heating was discussed. Neutral injection heating is effective, and ion temperatures achieved with neutral injection in PLT (Princeton Large Torus) have reached 5 to 7 keV. (This result is almost two years old.) However, high-frequency ion cyclotron heating may be less difficult from an engineering point of view.

Stellarators were discussed briefly. The audience was reminded that there is a possibility for reaching plasma equilibrium and stationary operation with external windings. Stellarators were compared with tokamaks. In stellarators, ion confinement is not good at low temperatures. Field-reversed pinches as well as many other aspects of pinches were discussed.

Kodomtsev concluded his talk by stating that magnetic confinement is in good shape and that a lot of experimental information is available. There is deep understanding of many problems. Tokamaks are close to scientific feasibility for demonstrating fusion.

The general invited talk, "Problems on Space Plasmas," demonstrated the difference between this conference and other plasma physics conferences. In may opinion, such a talk would not have appeared at the regular conferences where big machines dominate the proceedings so completely. In this talk, presented by Nishida, Obayashi gave an overall review of the physics of the solar wind, the formation of the magnetosphere of planets, and the transfer of energy from the solar wind into the magnetosphere. The magnetosheath bow shock, and shape of the magnetosphere were discussed. The magnetic field of the solar wind and the magnetic field of the magnetosphere interact and the phenomenon of "reconnection" was discussed. In the solar wind, the ion density is about 1 cm^{-3}, the ion kinetic energy is 1 keV, and the temperature is about 0.01 keV. In the plasma sheet to be found within several earth radii, the ion density is 0.1 cm^{-3} and the ion temperature is 1 keV. The question arises whether reconnection of field lines really takes place, and, if so, when and where it happens. Reconnection may take place between about 10 and 20 earth radii, and, perhaps, also beyond the lunar distance.

The general invited talk, "Laboratory Plasma Physics," discussed the interaction between high- and low-frequency waves in plasmas. The nature of pondermotive forces has been demonstrated through this interaction. Experiments illustrating this, using Q machines, were described. Electron plasma waves have two side bands due to modulation by ion acoustic waves. One can experimentally excite two electron plasma waves travelling in two directions by having a Q machine with two hot electrodes at opposite endds of the machine. This leads to a periodic pondermotive force field. In such experiments, one can detect standing electron waves and standing electron densities. The electron-beam excited ion-acoustic instability of Takamura and Aihara, the Kelvin-Helmholtz instability investigated by Sugai et al, and the ion acoutic instability investigation by Juul in 1977, were also mentioned. Michelsen discussed the evolution of wavetrains and pointed out that the sidebands have different group velocities. He also reviewed his own investigations of ion beam-excited electrostatic ion cyclotron instability, carried out in 1977.

The fifth general invited talk, "High Energy Density Plasma Physics-Phenomena and Measurements," was given by the director of the Rochester Laboratory for Laser Energetics of Rochester University. This institution

also operates a National Users Lasers Facility. This talk dealt with the application of high-power lasers to high-energy density plasmas. Besides the well-known application to laser fusion, Lubin discussed the use of high-power lasers to study the equation of state of materials at high pressure (greater than 30 Megabar), the production of intense, point source picosecond-pulsed x-rays by using such lasers, and the production of pulsed neutrons. The current capabilities of high-power lasers are such that the peak power generation is greater than 2 $\times$ 10^{13} watts; this is greater than 10 times the generating power capacity of the U.S.A. The electric fields in such lasers are about 10^{10} v/cm and the power flux is greater than 10^{18} w/cm^2. Knowing the equation of the state of materials under very high pressure is important for astrophysical applications and for implosion of spheres in the laboratory. At the high pressures being discussed, the inner atomic shell structure is important in determining the equation of state and for determining opacity. Monochromatic radiation opacities for materials under such high pressures have never been calculated, and the equation of state is not understood. Transport coefficients are lacking for such material. With such intense lasers focused on small particles of matter, intense, very short-time point sources of x-rays and neutrons are available. Thus, picosecond x-ray photographs and diffraction studies can be carried out. X-ray imaging systems, involving pinhole cameras, Fresnel zone plates, and grazing reflection, were discussed. The pinhole camera has been extended to 50 ps time-resolved x-ray spectroscopy, although the pinhole itself is destroyed. X-ray framing cameras in the 10- to 15-ps resolution range are under development or in place in laboratories around the world. Use of back-lighted x-rays, in which an external x-ray source is used in conjunction with an imaging pinhole streak camera, was discussed. Many laboratories are beginning to use monochromatic x-ray back lighting. Radiography of argon-filled gas microballoons compressed to 15 g/cm^3 were mentioned. Absorption spectroscopy has also been used in such compressional studies. The center of pellets have been doped with D-T and α-particle emission has been recorded. Experiments are now being set up to study flash x-ray diffraction. Lubin feels that the scientific spin-off from high-intensity lasers will be no less important than their application to fusion.

INVITED TALKS ON SPECIAL TOPICS

The 35 invited talks on special topics were distributed by countries as follows: Australia 1, Denmark 1, Federal Republic of Germany 2, France 4, India 1, Italy 1, Japan 7, Sweden 1, U.K. 1, U.S.A. 12, and U.S.S.R. 4.

We list the titles and authors of these talks in Appendix I and then review some of them here, briefly.

In Paper 1, Coppi discussed the evolution of the various Alcator tokamak devices: (Alcator A, 1969), Super Alcator (1971-72), Alcator C (1975-76), and the Ignitor (1976-77). It is hoped that these experiments will lead to an inexpensive, small-scale achievement of the ignition condition.

The motivation of the work described in Paper 8 is to gain a theoretical understanding of the mechanisms for anomalous transport. Electrostatic fluctuations and drift wave fluctuations were discussed. Experimental observations from the Princeton FM-1, the Wisconsin Octupole, and the GA Octupole were reviewed. Drift wave fluctuations cause little transport. However, drift waves give rise to transport through the mechanism of convective cells. A steady state three-dimensional simulation calculation was described, taking full ion dynamics into account. Electromagnetic fluctuation in a finite β plasma is also a possible candidate for anomalous diffusion.

Paper 9 was concerned with the importance of impurities in larger devices like INTOR. The helium generated in a reactor is itself an impurity. The energy balance for such a device was discussed. Rather accurate calculations are needed for extrapolation to large tokamaks. One has to take into account heat sources, and to know the energy deposition profiles resulting from neutral injection, high-frequency heating, and from α-particles. The spatial distribution of impurities and their degree of ionization must be known. INTOR will contain the ions D^+, T^+, He^{++}, and He^+ resulting from fusion, and possibly $O^+, \ldots, O^{8+}$, and $Fe^+, \ldots, Fe^{26+}$ from the walls. A set of continuity equations describing the loss of ions by transport and the gain by ionization was given. Thirty-eight equations are involved. One needs boundary conditions, and, from atomic physics, one needs data on collisional ionization by electrons and ions, radiative recombination, dielectronic recombination, autoionization, and

excitation. Uncertainties of factors of two to five are possible in these cross sections. Recent collections of data by Tazuma, Nakamura, and Inoue, and by Hawryluk were mentioned. A collection of data by the speaker was to have been out in a few weeks. He suggested that anomalous diffusion is due to turbulence.

In paper 10, Molvig talked about the textbook tokamak, where closed surfaces of magnetic field hold off high pressure. In practice, there are perturbations on this simple scheme. Resonant perturbations are the worst for confinement. In real world tokamaks, magnetic islands develop. It is this problem which was discussed theoretically in this paper. A history of toroidal instabilities was given, starting with the one discussed by Kadomtsev in 1962, and proceeding with the work of Coppi, Rosenbluth, Pearlstein, and Hirshman and the speaker, going up to 1979. Orbit stochasticity has been applied to both the turbulent electron response and to drift wave dynamics. This has been carried out for cylindrical geometry but not for toroidal geometry.

In Paper 11, various experiments with a Q machine were described in non-uniform magnetic fields. Production and suppression of instabilities, in curved magnetic fields and in mirror fields, were described. The Rayleigh-Taylor instability was induced in curved magnetic fields. In the mirror field, experiments on reflection and ion trapping as well as on the effects of collisions were discussed. Experiments were carried out varying the plasma density from the collisionless case to where collisions occur. The effects of turbulence on a collisionless plasma were also discussed. A grid was used to drive electron current in the plasma, and an instability was observed with a frequency a little higher than that of the ion cyclotron frequency. Experiments were described in which a periodic magnetic field was set up in a Q machine, with two hot plates at either end of the tube. A potential is applied to one hot plate with respect to the other. One can produce either an electron beam or an ion beam in this periodic structure. Periodic magnetic fields were able to both suppress and enhance instabilities.

Paper 12 discussed the theory of magnetoacoustic waves in non-uniform density, current-carrying, high-temperature, collisionless plasmas. This work has application primarily to plasma diagnostics and possibly to plasma heating. Propagation of waves were discussed for non-uniform plasmas with finite conductivity. The amplitude and phase of a wave depends on the density and temperature of the plasma. This raises the possibility of using such waves as a diagnostic tool. Experiments done by the Freibourg group on phase velocity versus frequency give a rough qualitative agreement between theory and experiment. Calculations are being made for a current-carrying plasma with viscosity present. This is dissipative MHD theory. Experiments on MHD waves are being done in linear geometry, by launching waves in an afterglow by a solenoid. One can convert the experience with linear geometry to toroidal geometry. It is possible to use experimental results to obtain density profiles. Results can be compared with those obtained with laser interferometers and the agreement is good. One can also determine atom density because the atoms are coupled into the waves. A combination of measurements on the magnetic acoustic wave and a direct measurment of the electron density can allow one to determine the density of two kinds of ions, or of one ion and one neutral. This should be useful in tokamak experiments to measure the composition of two species present and also to measure the mass density. The talk concluded with a discussion of the use of magnetoacoustic waves as a method of plasma heating. Interest has already been shown in using the ion-ion hybrid mode fast waves as a heating tool for tokamaks. Heating by magnetohydroacoustic waves has been studied very little, in diffuse pinches. Such pinches will need supplementary heating. This is the objective of experiments to be carried out over the next year or two.

Papers 15 and 16 discussed "stochasticity." I did not hear Paper 15, but I did hear 16 and had the pleasure of an extended conversation about it with A. Kaufman. B. Chirikov, author of Paper 15, introduced the concept of stochasticity in 1971. If one has two orbits of charged particles with slightly different initial conditions in non-uniform magnetic fields,then the orbits diverge more and more as time goes on. This has nothing to do with collisions. Stochasticity has been invoked to explain such phenomena as anomalous motion of charged particles in plasmas. Perhaps some instabilities can be explained by this approach. There has been lots of resistance to this approach. A book by Billingsley gives the mathematical theory; Shimada explains stochasticity in the language of physics.

Papers 17 through 24 were all concerned with the heating of plasmas by waves, giving some indication of the importance associated with this topic.

Paper 32 discussed theory and experiments of stimulated Brillouin scattering when an intense laser beam illuminates a material. In addition to forming a plasma, the incident light is scattered with a red shift. The two waves interact and beats develop. Three coupled wave equations must be taken into account, the incident and scattered wave as well as the ion acoustic wave. A pondermotive force develops due to the beat. The equations were solved in the finite region of interaction Brillouin scattering is less important for CO_2 lasers than for glass lasers. The ions gain energy from the ion acoustic wave developed. Experiments were carried out at Naval Research Laboratory in which a laser was focused on a solid target with the resulting plasma leaving normally. There is a red shift due to the plasma and a blue shift due to the motion of the plasma. Experiments carried out with glass lasers at Livermore, with CO_2 lasers at Los Alamos, and with I_2 lasers at Garching were mentioned, as well as some work in Canada and Osaka. Brillouin scattering can be a serious energy loss when a material is irradiated. With CO_2 lasers, the loss is less than 10%, but, with glass lasers, the loss is greater than 10%. Experiments on this effect, using CO_2 lasers at the University of Washington and University of California, Los Angeles, showed an energy loss less than 5% due to this effect. Polarization effects to be expected in the backscattered light were discussed. Turbulence has a depolarizing effect. Dielectric reflections from discontinuities in densities are superimposed on Brillouin scattering. The speaker said that lots had been learned about Brillouin scattering the last five years.

Paper 33 also discussed Brillouin scattering from matter-laser interaction. He considered the wavelength dependence of reflectivity from a plasma due to stimulated Brillouin scattering, absorpiton by inverse bremstrahlung and by collective processes, and heat transport from the ablation surface. He discussed damping of the ion acoustic wave due to linear and nonlinear damping mechanisms. Systematic experiments on stimulated Brillouin scattering have been carried out at Osaka and have been explained by Mima's theory. A second topic discussed by Mima was the absorption of laser light due to classical and collective processes such as resonant absorption by Langmuir oscillations. In summarizing his talk, Mima agreed with Chen (paper #32 that stimulated Brillouin scattering is serious for the 1.06 μm laser and that the effect is strongly suppressed and almost independent of the incident power for the 10.6 μm laser.

Paper 34 discussed the diagnostics associated with the transport of electrons in tokamaks. There is no generally accepted theory of anomalous electron transport in tokamaks. Perhaps such anomalous transport is caused by microturbulence. There is a lack of experimental information on turbulence in tokamaks, and the paper was devoted to the study of this effect. Density fluctuations were measured by 2-mm microwaves in the PLT (Princeton Large Torus). Density fluctuations between 0.5 and 1% were observed. Hard x-rays from runaway electrons were modulated in amplitude to the extent of 10-30% of the total flux. The frequency spectrum of these fluctuations is very similar to that of the electron density fluctuations. Another subject discussed was the fluctuations in electron density of ohmic-heated plasmas as well as plasmas heated by the injection of energetic neturals. Injection of 2.5 megawatts of neutrals for 150 ms produces enhancement of ion temperature and an increase in the average density from 1.5×10^{15} to 2.5×10^{15} cm^{-3}. Most of the increase can be explained by the beam particles. Little or no change in electron temperature was observed for this case. There was enhancement of turbulence by the neutral injection.

In Paper 35, diagnostics for inertial confinement were discussed. Such studies are now starting at most major laboratories around the world. In inertial confinement, the core emits fusion particles and x-rays copiously. Some of the material in Paper 5 of the general invited talks was covered, such as the use of pinhole x-ray cameras, x-ray backlighting, as well as zone plates.

ORAL SESSIONS

Authors who felt their papers should be presented orally were asked to indicate that fact when submitting their abstracts. Of these, about 100 papers were selected for oral presentation. About 15 minutes were allowed for presentation and discussion of each paper. The distribution by country of papers presented in the oral sessions was Austria 1, Belgium 1, Bulgaria 1, Canada 3, Federal Republic of Germany 8, France 6, India 5, Japan 33, Sweden 2, Switzerland 1, Thailand 1 (senior author is temporarily in Thailand, one author is from New Zealand, and the other from U.K.), U.K. 2, U.S.A. 23, and U.S.S.R. 13.

An idea of the nature of the papers may be obtained from the titles of the sessions:

- Instability and Transport in Magnetic Fusion Devices (two sessions),
- Electrostatic Waves (two sessions),
- Reverse Field Plasmas,
- Wave-Particle Interaction and Free Electron Laser,
- Turbulence and Anomalous Transport,
- Hydromagnetic Waves and Reconnection,
- Lower Hybrid and Cyclotron Waves,
- Fundamental Theory (two sessions),
- Plasma Heating and Acceleration,
- MHD Instabilities,
- Soliton, Shock Wave and Double Layer,
- Laser Plasma system, and
- Plasma Diagnostics.

It is not feasible to even list titles of the papers, but it may be interesting to list papers from countries making only one contribution. Such a list follows:

- "Analytical Three-Dimensional Force-Free Toroidal MHD-Equilibria," by F. F. Cap, University of Innsbruck, showed that the equations curl $\vec{B} = \gamma \vec{B}$ and div $\vec{B} = 0$ with γ constant allow analytical three-dimensional solutions in quasitoroidal coordinates.

- "Nonlinear Variational Principle for MHD Stability," by D. K. Callebaut and A. H. Khater, University of Antwerp, discussed a variational method for ideal MHD stability first proposed by Bernstein, Frieman, Kruskal, and Kulsrud, and later generalized and simplified by the present authors. In the present paper, the method is further generalized and simplified, and applied to some examples analytically. One of the examples studied analytically is the plane parallel slab.

- "Nonlinear Interaction of Surface Waves in a Semi-Indefinite Plasma," by V. Atanassov, E. Mateev, and I. Zhelyazkov, Sofia University, discussed the nonlinear coupling of three high-frequency surface waves propagating along a plasma-dielectric interface through low-frequency plasma density perturbations caused by the surface waves.

- "Magneto-Viscous Stabilisation of Resistive Instabilities," by R. J. Hoskings, University of Waikato, Hamilton, New Zealand (now on leave to Asian Institute of Technology, Bangkok), and D. C. Robinson, Culham Laboratory, U.K. (This paper was listed as originating from Thailand.) In this paper, calculations in cylindrical pinch geometry showed that resistive modes in plasmas are stabilized by parallel ion viscosity in configurations with significant field curvature.

POSTER SESSIONS

About 300 papers were presented in poster sessions. The poster sessions were held on the first four days of the conference. Although posters were displayed for extended periods, authors were only expected to be present during 50 minutes. This allowed authors of poster sessions to attend othe other sessions. Of the 50 minutes, 30 were sandwiched in between the end of a coffee break and 20 were at the end of the viva voce sessions. This accounted for the fact that the poster sessions were not well attended, but individual intense discussions did occur. The distribution of poster session papers by countries, not counting cancellations and a few post-deadline papers, were: Australia 1, Austria 3, Belgium 4, Brazil 1, Bulgaria 3, Canada 3, China 2, Czechoslovakia 3, Denmark 3, Federal Republic of Germany 12, France 8, Ghana 1, India 14, Iran 1, Italy 6 1/2, Japan 127, Kenya 1, Netherlands 2 1/2, Poland 1, Portugal 4, South Africa 3, Sudan 1, Sweden 1, Switzerland 4, U.S.A. 34, U.S.S.R. 56, Venezuela 1, and Yugoslavia 1.

The poster papers were arranged in groups under subject headings as listed in Appendix II. Also listed there are the total number of papers under each subject heading, and countries of origin. Perhaps this will give an opportunity for the reader to learn the fields of activities in the various countries.

CONFERENCE SUMMARY BY M. N. ROSENBLUTH

Throughout the conference, reference was made to the summary which would be made by M. N. Rosenbluth. The meeting in Nagoya started just two weeks after the dramatic announcement that Rosenbluth would leave the Institute for Advanced Study to head the U.S. Institute for Fusion Studies in Austin, Texas. Rosenbluth seems to be a living legend in plasma physics, and is considered an oracle. Thus, his comments were listened to very carefully. It was a relief to hear him say that he had not understood every paper.

In general, Rosenbluth discussed some contributed papers rather than the invited ones. It will not be possible to cover all the topics which Rosenbluth discussed. He did say that he was impressed with the large number of basic plasma experiments which had been presented at the conference. He stated that, in the United States, we were too accustomed to talking about the large machines.

Rosenbluth discussed two contributed papers in the field of space physics:

- "X-ray Burst Sources," S. Hayakawa, Nagoya University, and
- "Fermi Acceleration in Interplanetary Shock Waves," T. Terasawa and S. Miyaji, University of Tokyo.

The first paper described an attempt to understand the new mode of x-ray bursts discovered by the Japanese x-ray satellite "Hakucho" in 1979. It was suggested that the burster is a neutron star, with the magnetic dipole moment nearly aligned with the axis of an accretion disk. The author suggested that the observed bursts are associated with the buildup of the boundary layer in the accretion disk surrounding the dipole magnetic field. In the second paper, recent observations of acceleration phenomena in the earth's bow shock were explained in terms of a Fermi process in which the energy spectra of the particles were calculated.

Two contributed papers on laboratory plasmas were mentioned.

They were:

- "Observation of Current-Driven Alfvén Wave Instabilities," M. Inutake, Nagoya University, R. Hatakeyama, Tohuku University, and T. Akitsu, Kyoto University; and

- "*Experiments on Merging* of Two Current-Carrying Plasma Columns," S. Besshou and N. Kawashima, University of Tokyo.

In the first of these two papers, instabilities were reported in linear pinch which cannot be considered as Kodomtsev instabilities. The second paper reported the merging of two pinches. Ions were observed to be accelerated at the crossing point. The experiment concerned itself with how rapidly magnetic reconnection occurs. Rosenbluth referred to this as a well-designed and clean experiment.

"The Role of Strange Attractions in Models of Magnetohydrodynamic Turbulence," by E. K. Maschke and N. Kawashima, University of Tokyo, discussed the analogy of MHD instabilities with instabilities of thermally-stressed fluids and suggested that strange attractors may play a similar role in the turbulence of strongly-confined plasmas. Non-linear equations up to 136 mode amplitudes were derived, and solved numerically. The results were compared with those obtained from a 2D fluid code.

The R. F. heating results in a variety of large machines show that ion cyclotron heating can be an effective means of plasma heating.

The discussion of anomalous transport in terms of stochastic fields is considered to be an outstanding problem in physics. There may be some unpleasant surprises in larger machines if we do not understand anomalous transport. Molvig's theory was discussed critically.

The Bumpy Torus work in the United States and Japan was reviewed. Experimental results from the Nagoya Bumpy Torus confirm results obtained with the Elmo Bumpy Torus of Oak Ridge National Laboratory. It is found that a relativistic electron ring can stabilize a background plasma. One may be able to treat the ring as a hard conductor which does not respond to $\vec{E} \times \vec{B}$ fields. The ring would not be moved by MHD forces.

Mirrors and cusps were mentioned briefly, as well as the many papers on end plugging. Emphasis was placed on electrostatic end plugging where electrons are confined by the electrostatic potential in a thin sheath giving a small loss area (V. P. Pastukhov, U.S.S.R.). Nagoya and Lawrence Livermore Laboratory both reported enhanced confinement in tandem mirrors, and the confinement time is increased by a factor of 10 over simple mirrors. Thermal barriers promise larger gains by also trapping electrons in the central region.

Finally, Rosenbluth raised the following questions:

- What is pulsar emission?
- What is the role of resonance broadening in quasilinear theory?
- How does a rapidly drifting component, as in the Bumpy Torus, affect interchange stability?
- How effective can end-stoppering be in mirrors, and can thermal barriers or RF plugging work?
- How does the tearing mode behave in the collisionless regime (high β tokamak)?
- Do stochastic fields in plasmas tend to develop? Can we understand anomalous scaling (coefficient of diffusion independent of gradients)?
- How does the hot electron spectrum arise?

Rosenbluth ended his technical summary with an impassioned and moving plea for the members of the conference to work for international peace. The members of the conference from all countries showed good will toward each other.

NEXT MEETING OF THIS CONFERENCE

At a meeting of the International Organizing Committee of the present conference held near the end of the meeting, it was decided that the conference had been very successful, and that a second such conference should be held in 1982 in Sweden. The chairman of the International Organizing Committee is to be H. Wilhelmsson, Institute for Electromagnetic Field Theory, Chalmers University of Technology, Göteborg, Sweden. The meeting will be held in Goteborg.

ANNOUNCEMENTS POSTED AT THE CONFERENCE

- The first announcement of "XVth International Conference on Phenomena in Ionized Gases" to be held in Minsk, U.S.S.R., July 14-18, 1981, was available at this conference. For further information, one should write to:

  Organizing Committee of ICPIG-15
  Institute of Physics
  BSSR Academy of Sciences
  Leninskii Prospect, 70
  Minsk, BSSR (USSR), 220602.

I remember vividly being one of the five Americans who attended the first of these conferences in Oxford in 1953!

- An announcement of "X European Conference on Controlled Fusion and Plasma Physics," was posted at the conference. This conference will be held September 14-19, 1981, in Moscow. The title deadline is February 20, 1981, and the paper deadline is May 5, 1981. Three workshops will be held in conjunction with the conference:

    1. Stellarators (Moscow, Lebedev Physical Institute),
    2. Plasma Focus (Moscow, Lebedev Physical Institute), and
    3. Open Traps (Institute of Nuclear Research, Novosibirsk).

  Inquiries concerning this tenth conference may be addressed to:

  M. S. Rabinovich
  Lebedev Physical Institute
  Leninsky Prospekt 55
  Moscow, U.S.S.R.

- An announcement was posted for the "2nd Joint Grenoble-Varenna International Symposium on Heating in Toroidal Plasmas," to be held in Como, Italy. (Either the announcement did not list the dates or I failed to note them.)

RELATED MEETINGS HELD AFTER THE CONFERENCE

Three meetings related to the subject matter of the conference were held as follows:

- "International Symposium on Physics in Open-ended Fusion Systems," April 15-18, Tsukuba. Organizers: S. Miyoshi and T. Kawabe, Institute of Physics, Tsukuba University.
- "International Workshop on Relation between Laboratory and Space Plasmas," April 13-14, Tokyo. Organizer: H. Kikuchi, Nihon University.
- "Workshop on Optimization of Toroidal Confinement," April 14-16, Hiroshima. Organizers: S. Inoue and K. Nishikawa, Hiroshima University, and K. Itoh, Japan Atomic Energy Research Institute (JAERI).

NOTICE OF BOOK PUBLISHED

At the conference a notice of a book, "Intrinsic Stochasticity in Plasma," edited by G. Laval and D. Gresillon, was posted. These are proceedings of the international workshop in Cargese, held June 17-22, 1979.

APPENDIX I

Invited Talks on Special Topics

1. "Plasma Physics in High Density Tokamak Operation," B. Coppi, Massachusetts Institute of Technology
2. "High Stability Studies in ISX-B Tokamak," J. F. Lyon, Oak Ridge National Laboratory
3. "Initial Results of the Tandem Mirror Experiment (TMX) at the Lawrence Livermore Laboratory," B. G. Logan (presented by D. P. Grubb), Lawrence Livermore Laboratory
4. "Physics of REB-Plasma (Relativistic Electron Beam-Plasma) Interaction," D. D. Ryutov, Institute of Nuclear Physics, Novosibirsk, U.S.S.R.
5. "Waves in Space Plasmas," M. Ashour-Abdalla, University of California, Los Angeles
6. "Double Layer-Theory and Experiment," S. Torven, Royal Institute of Technology, Stockholm, Sweden
7. "The Farley-Buneman Instability in the Polar Cap Ionosphere," N. D'Angelo, University of Iowa
8. "Computer Simulation of Anomalous Transport," H. Okuda (presented by W. W. Lee), Princeton Plasma Physics Laboratory

9. "Impurity Transport in Tokamaks," D. Düchs, Max-Planck-Institut für Plasmaphysik, Garching, Federal Republic of Germany
10. "Recent Progress toward a Self-Consistent Theory of Anomalous Transport in Tokamaks," K. Molvig, Massachusetts Institute of Technology
11. "Plasma Waves in Simple Nonuniform Magnetic Fields," N. Sato, Tohoku University, Sendai, Japan
12. "Magnetoacoustic Waves in Current-Carrying Plasma," M. H. Brennan, Flinders University, Bedford Park, Australia
13. "Propagation and Stability of Solitary Waves in Plasma," K. H. Spatschek, University of Essen, Federal Republic of Germany
14. "Nonlinear Theory of Plasma Fluctuations," A. G. Sitenko, Institute of Theoretical Physics, Kiev, U.S.S.R.
15. "Adiabatic Invariants and Stochasticity in Magnetic Confinement System," B. Chirikov, Institute of Nuclear Physics, Novosibirsk, U.S.S.R.
16. "Recent Developments in the Analysis of Stochasticity," A. Kaufman, Lawrence Berkeley Laboratory
17. "ICRF (Ion Cyclotron Radio Frequency) Heating Experiments in DIVA," K. Odajima, Japan Atomic Energy Institute, Ibaraki, Japan
18. "ICRF Heating Experiments in PLT (Princeton Large Torus)," J. C. Hosea (presented by D. L. Q. Hwang), Princeton Plasma Physics Laboratory
19. "ICRF Heating Experiments in TFR," J. Jacquinot, CEMFAR, Fontenay-aux-Roses, France
20. "Lower Hybrid Heating of Plasma," G. Briffod, Grenoble, France
21. "Lower Hybrid Heating in JIPP T-11 (Japan Institute of Plasma Physics Torus-II)," K. Ohkubo, Institute of Plasma Physics, Nagoya, Japan
22. "Electron Cyclotron Heating of Plasma," S. Tanaka, Kyoto University, Kyoto, Japan
23. "RF Heating of Electrons," D. Piliya, A. F. Ioffe Physico-Technical Institute, Leningrad, U.S.S.R.
24. "Dielectric Effects in Electron Cyclotron Absorption," M. Bornatici, Universita di Pavia, Pavia, Italy
25. "Self-organizing Motions in Finite β Plasma and Their Application to Plasma Confinement," A. Hasegawa, Bell Telephone Laboratories, Murry Hill
26. "New Effects in Nonlinear Plasma Turbulence Theory and its Application to Plasma Heating," N. Tsytovich, Lebedev Institute of Physics, Moscow, U.S.S.R.
27. "Importance of Mode-Mode Coupling Effects in Quasilinear Theory," G. Laval, Ecole Polytechnique, Paliseau, France
28. "Surface Magneto-Plasmons in Semiconductors," C. Uberoi, Indian Institute of Science, Bangalore, India
29. "Non-Neutral Electron Plasmas," T. O'Neil, University of California, San Diego
30. "Plasma Dielectric Transition near the Critical Point of Liquid Metals," F. Yonezawa, Kyoto University, Kyoto, Japan
31. "Physics of High Current Ion and Electron Beams," R. N. Sudan, Cornell University
32. "Stimulated Brillouin Scattering," F. F. Chen, University of California at Los Angeles
33. "Laser Plasma Interaction," K. Mima, Institute of Laser Engineering, Osaka University, Osaka, Japan
34. "Diagnostics of Fluctuations," E. Mazzucato, Princeton Plasma Physics Laboratory
35. "High Resolution Plasma Diagnostics," T. Raven, Rutherford Laboratory, Chilton, Didcot, U.K.

APPENDIX II

Poster Sessions

- Electron Waves (11 papers; France 2, India 1, Japan 4, U.S.A. 1, and U.S.S.R. 3),
- Ion Acoustic waves (11 papers; India 1, Japan 3, South Africa 3, Switzerland 2, U.S.A. 1, and Venezuela 1),
- Cyclotron Waves and Other Waves in Plasmas (18 papers; Austria 1, France 1, Italy 1, Japan 5, Portugal 3, U.S.A. 2, and U.S.S.R. 5),
- Tokamaks and Stellarators (15 papers; F.R.G. 2, Iran 1, Japan 9, Netherlands 2, and U.S.A. 1),
- Plasma Focusing, Pinches, and High-β Plasmas (11 papers; Brazil 1, India 1, Italy 1, Poland 1, and Japan 7),
- Bumpy Torus, Field Reversed Configurations (3 papers; U.S.A. 3),
- Tandem Mirrors (2 papers; Japan 1, and U.S.A. 1),

- High Pressure Discharges, Vortex Gas Flow (5 papers; F.R.G. 1, Italy 1, and Japan 3),
- Statistical Theory (16 papers; Belgium 1, Bulgaria 1, France 1, Japan 4, Kenya 1, U.S.A. 2, and U.S.S.R. 6),
- Transport Phenomena (8 papers; China 1, India 1, Japan 4, Sudan 1, and U.S.A. 1),
- Whistlers (3 papers; F.R.G. 1 and Japan 2),
- Space and Astrophysical Plasmas (14 papers; Canada 1, Czechoslovakia 1, France 1, India 2, Japan 7, Switzerland 1, and U.S.S.R. 1),
- Parametric Instabilities and Wave-Wave Coupling (13 papers; Canada 1, China 1, Czechoslovakia 1, Denmark 1, Italy 1, Japan 3, and U.S.S.R. 5),
- Filamentation and Other Nonlinear Processes (3 papers; F.R.G. 1, and India 2),
- Surface Waves (5 papers; Bulgaria 2, Ghana 1, U.S.S.R. 1, and Yugoslavia 1),
- Propagation of Waves (5 papers; Portugal 1, Japan 2, U.S.A. 1, and U.S.S.R. 1),
- Drift Cyclotron Loss Cone Instability (4 papers; India 1, Japan 2, and U.S.A. 1),
- Instabilities of Drift, Tearing and Other Modes (12 papers; Austria 1, France 1, Italy 1, Japan 7, and U.S.A. 2),
- Stimulated Scattering Processes (2 papers; France 1 and U.S.A. 1),
- Beam-Plasma Interaction (19 papers; Austria 1, India 2, Japan 9, U.S.A. 1, and U.S.S.R. 6),
- Generation of Fast Ions, Electrons and Neutral Beams (6 papers; Czechoslovakia 1, France 1, Japan 2, and U.S.S.R. 2),
- Stability Analysis (8 papers; Belgium 1, Canada 1, F.R.G. 1, India 1, Japan 1, U.S.A. 2, and U.S.S.R. 1),
- Electron Cyclotron Wave Heating (7 papers; Italy 1/2, Japan 3, Netherlands 1/2, U.S.A. 2, and U.S.S.R. 1),
- Lower Hybrid Wave Heating (14 papers; France 1, Japan 5, U.S.A. 5, and U.S.S.R. 3),
- Ion Cyclotron Radio Frequency Heating (7 papers; France 1, F.R.G. 1, Japan 4, and U.S.A. 1),
- Magnetic Reconnection (5 papers; Italy 1, Japan 1, U.S.A. 2, and U.S.S.R. 1),
- Plasma Diagnostics (Probe Method) (5 papers; France 2, Japan 2, and U.S.S.R. 1),
- Plasma Diagnostics (Infrared Holography) (3 papers; Japan 1 and U.S.S.R. 2),
- Plasma Diagnostics (Far Infrared Scattering) (3 papers; France 1 and Japan 2),
- Plasma Diagnostics (Particle Beam Probing) (4 papers; Japan 4),
- Plasma Diagnostics (Optical and X-ray Measurements) (6 papers; Japan 5 and U.S.S.R. 1),
- Lasers (2 papers; Japan 2),
- Laser-Produced Plasmas (13 papers; France 1, F.R.G. 1, India 1, Japan 7, and U.S.S.R. 3),
- Inertial Confinement Fusion (11 papers; Australia 1, Japan 8, and U.S.A. 2),
- Non-Linear Methods (5 papers; Belgium 2, France 1, and Japan 2),
- Effects of Ponderomotive Forces (5 papers; F.R.G. 1, India 1, Japan 1, Switzerland 1, and U.S.S.R. 1),
- Solitons, Shocks, and Vortices (14 papers; Denmark 2, F.R.G. 2, Japan 6, U.S.A. 1, and U.S.S.R. 3),
- Langmuir Turbulence, Double Layers and Convective Cell Formation (9 papers; F.R.G. 1, Japan 1, Sweden 1, U.S.A. 1, and U.S.S.R. 5).

The above categories are moderately self-evident to the plasma physicist. It might be helpful to state that the category "laser" included one paper on population inversion in a freely expanding hydrogen plasma and the other on an experimental study of an electron cyclotron maser.

APPENDIX III

Reference Notes

1. Nagoya is a city of almost three million people and is located in the center of Japan on the island of Honshu. It is one of Japan's great industrial cities. The city was largely destroyed during World War II and has been rebuilt as a modern city with broad streets. Nagoya is the fourth largest city in Japan, and among its educational institutions are Nagoya University and the Nagoya Institute of Technology. Nagoya University, in turn, houses the largest institution in Japan devoted to plasma physics, namely, the Institute of Plasma Physics. In an opening address, F. W. Crawford of Stanford University referred to Nagoya as the mecca for plasma physics in Japan. In addition to the plasma physics at the Institute of Plasma Physics, there is also some plasma physics work going

on at Nagoya University which is not connected to the work of the Institute. The work of Professor S. Takeda, Department of Electrical Engineering, is such an example. Takeda and his colleagues are studying the propagation of waves in plasmas.

2. The first attempt to produce thermonuclear power from plasmas may have been due to Richter, in Argentina, in the late 1940s. Richter convinced Peron to set up a mammoth laboratory in the mountains of Argentina. In 1949, Peron asked Prince Bernhard of the Netherlands to provide a scientist to evaluate Richter's program. The scientist chosen was C. Bakker, and I met Bakker in the summer of 1949 just after he had returned from Argentina. Apparently, high-current arcs were established, but there was no instrumentation to study the effectiveness of the procedure. Bakker described the elaborate reception he received, the private airplane, and landing strip associated with Richter's mountain laboratory. After Bakker's report, the organization was disbanded.

3. The Fusion Research Association of Japan was founded 20 years ago; this indicates how long Japan has been interested in this problem. It was founded at the suggestion of Professor H. Yukawa and Dr. K. Husimi, president of the Science Council of Japan. The president of the Fusion Research Association of Japan is Professor S. Nagao, Faculty of Engineering, Tohoku University, Sendai. Nagao described the formation of the association as a "fusion" of two groups, one in gaseous electronics, and the other in nuclear physics, which spoke different languages. A second "fusion" undertaken by the organization is the arrangement of a "Joint Conference on Fusion Research" which will involve five societies:

- Physical Society of Japan,
- Atomic Energy Society of Japan,
- Japan Institute of Metals,
- Institute of Electrical Engineers of Japan, and
- Japan Society of Applied Physics.

The conference will be held February 4-6, 1981, at Tsukuba. The Association puts out a monthly journal in Japanese. In contrast to the 20-year history of the Fusion Research Association, the Society for Atomic Collision Research (Japan) was formed in 1976, the Institute of Electrostatistics Japan in 1977, and the Japanese Research Group in Electrical Discharges (JRED) was formed a few years ago.

4. During the conference, afternoon tours of the Institute of Plasma Physics (IPP) were conducted. I went on such a tour. I had visited IPP briefly once before. Hopefully, a Bulletin article will appear on this important institution. For now, a brief summary is given of the installations visited on the tour.

- JIPP T-II (Japan, Institute of Plasma Physics, Torus-II). This is the main project of IPP and is a hybrid stellarator-tokamak. The machine is now being operated as a stellarator, the tokamak mode of operation having ended. JIPP T-II was proposed in 1972, studied in detail during 1973, and was constructed during 1974-75. Experiments began in 1976. At the present time, heating of the plasma is by neutral beam injection and by R.F. at the lower hybrid frequency. The major radius of the torus is 91 cm, the plasma radius is 17 cm, and the toroidal field is 30 kG. Plasma current of 150 kA (max) flows for 0.3 to 0.5 sec, and the plasma produced has an electron temperature of 1 keV, an ion temperature of 0.7 keV, and a plasma density of 5×10^{13} cm^{-3}. The plasma confinement time is about 0.015 sec. The machine is being operated with ordinary hydrogen.

- RFC-XX (Radio Frequency Containment-XX). The aim RFC is to investigate the RF plugging and/or heating in anopen-ended magnetic trap, either of mirror or cusp type. The RFC-XX device is a double-cusped tandem system with RF plugs installed at end. This is the world's largest cusp machine. It is a linear machine containing two-point cusps and two-line cusps. The machine is 10 m long. The point cusp magnetic field is 40 kG and that of the line cusp is 20 kG. The magnetic field in the central section is almost uniform and is 10 kG. The RF generator for line cusp plugging is 1 megawatt at 45 MHz and that for point cusp plugging is 1 megawatt at 85 MHz. The machine is being operated with ordinary hydrogen.

- NBT-1 (Nagoya Bumpy Torus). The Nagoya Bumpy Torus consists of 24 connected toroidal mirrors with 2:1 mirror ratio and two 80-cm straight mirror sections connecting half circles into a race track. The plasma is produced, heated, stabilized, and confined by high-power microwaves at four frequencies: 18 GHz, 10.6 GHz, 8.5 GHz, and 6.4 GHz. The maximum magnetic field at midplane is 4 kG and is 8 kG at the mirrors. The major radius is 1.6 meter and the minor radius is 0.2 meter. Once again, the gas being used is normal hydrogen. The electron-ion density in the device is about 10^{12} cm^{-3}, the electron temperature is about 200 eV, and that of the ions is about 50 eV. A typical pressure in the device is 5×10^{-5} Torr. A similar machine has been operating since 1973 at Oak Ridge National Laboratory, the Elmo Bumpy Torus (EBT). The Nagoya machine has been operating since 1978.

- REB (Relativistic Electron Beam). Research on the application of intense relativistic electron beams to controlled nuclear fusion has been going on at IPP for some years. The present situation involves the installation, last year, of a Physics International Pulserad Model 445 W electron accelerator (nicknamed Phoebus III) and the construction of SPAC-VI (Super Plasma Accelerator-VI) to be used in conjunction with Phoebus III. A special building was provided for Phoebus III. It is hoped that, by short-pulse injection of the electron beam, the period to form the electron beam ring can be short enough to avoid the growth of MHD instabilities. Cornell University has a similar machine, and one was installed in Novosibirsk last year.

- Laser Produced Plasmas, HALNA. HALNA (Hexa Amplifying Laser in Nagoya) is a 100-GW peak power neodymium laser being used for a variety of purposes. A single pulse is selected with a Pockels cell out of the mode locked laser and is injected into a large amplifier chain which contains spatial filters and Faraday isolators. The integrated energy over a single pulse is 5 Joules/cm^2. Laser-produced plasmas are being used for the study of x-ray and vacuum ultraviolet spectroscopy of highly ionized atoms. Last year, for example, a paper "Kα Emission Induced by X-Rays from Laser-Produced Plasma" by N. Yamaguchi was published in the Journal of the Physical Society of Japan. It is expected that, by next January, the laser will be used to irradiate solid deuterium pellets.

- Research Information Center. This name has been used, since the foundation of IPP in 1961, for the organization providing distribution of scientific documents including a preprint series. However, in 1977, a new organization was formed as a national center administratively affiliated to IPP, which is responsible for national, as well as international, information service in nuclear fusion research. The official name (in Japanese) is Center for Research Planning and Information for Nuclear Fusion, if literally translated, but an abbreviated name, Research Information Center, has been adopted. Professor S. Hayakawa is director of the center. A large part of the activities of the center are supported by working groups, which are organized for specific subjects by the participation of scientists belonging to various institutions all over Japan. The following working groups are now active:

  - Working Group on Nuclear Fusion Reactors
  - Working Group on Atomic Processes in Plasmas
  - Working Group on Plasma-Wall Interactions.

  On my previous visit, I had an extensive visit with the Atomic Processes in Plasmas Working Group.

- There is also a large atomic physics experimental activity at IPP. I saw this activity on my previous visit. This work will not be described here, as it was not on the tour.

5. Ghana, Kenya, Sudan, and Venezuela were represented by one paper each in the poster sessions. However, the conference attendance list contained no names from these countries. Whether these papers were presented, or whether their authors attended, I cannot say.

6. The attendee from Thailand was not Thai but was Dr. Roger Hoskings, of the Department of Computer Application, Asian Institute of Technology in Bangkok. Dr. Hoskings is from New Zealand.

7. I was told that only 22 of the 32 listed people from the U.S.S.R appeared.

8. INTOR is acronym for International Tokamak Reactor. This is a very large tokamak to be completed in the 1990s and would be much larger than those now under construction. INTOR is being studied under the auspices of IAEA (International Atomic Energy Agency), and would be the next-generation machine, after the present four large ones now under construction. Cost estimates vary between $1 billion stated publicly, and $3 billion, the estimate of at least one person heavily involved in the deliberations. Intense multinational physics studies of INTOR have been going on for some time, and they may be said to have been completed. A pre-engineering design stage is being planned for the next year or year and a half. An important INTOR meeting was held in Vienna last March, and an IAEA Advisory Meeting for Large Tokamak Experiments was held in Tokyo, April 14-18, immediately after the present conference. Another important INTOR meeting is to be held in Brussels in June. An official proposal to build INTOR will be submitted to the governments involved in October, 1980. Kadomtsev's talk was strongly supportive of going ahead with INTOR, and the U.S.S.R. is said to favor the proposal. Many countries, including the U.S.A., U.S.S.R., Japan, Germany, France, etc., would have to agree on this project. The location of the machine would have to be negotiated. It is interesting to note that an Ad Hoc Experts Group on Fusion for the Department of Energy, in 1978, warned against excessive reliance on tokamaks.

XVII GENERAL ASSEMBLY, INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS (IUGG)

Robert E. Stevenson

Once again, as in previous meetings of the IUGG over the past four decades, and in the three Joint Oceanographic Assemblies (1959, 1966, and 1976), scientists from the United States dominated the programs of all the associations as well as those of the General Assembly.

By the end of the first week of the two-week session, there were 1940 delegates registered at the IUGG headquarters at the Australian National University, Canberra. Another 300-plus, who had registered by mail, were not in attendance. Of the 1940 present, 506 were from the United States (26%), and 466 from Australia, constituting, therefore, 50% of the total. Adding together the delegates from West Germany (99), the United Kingdom (92), France (85), Denmark (23), Switzerland (22), Belgium (18), Netherlands (16), Norway (16), Sweden (13), and Finland (10), we learned that those 394 scientists accounted for another 20% of the total delegates. Consequently, the U.S., Australian/New Zealand, and western European scientists completely dominated the assembly by making up 73% of the participants. There were 82 delegates from the Soviet Union (even Japan sent 93), a typically dismal showing from their apparently vast supply of scientists.

The domination in numbers of delegates from the United States, Australia, and western Europe carried over into the scientific symposia. This was well exemplified by the papers presented in the 20 interdisciplinary symposia of the General Assembly (Appendix I). Of the 515 papers accepted by the program committees for presentation, 213 (41%) were by U.S. scientists. Australia offered the next largest number (51), with the Soviets pulling up a poor third with 35 papers accedpted for presentation.

Again, by adding together the papers from the United States, Australia/New Zealand, and western Europe, we learn the magnitude of the dominance by scientists from those parts of the world.

There were certain fields of research where one would naturally expect the U.S. scientists to excel, such as geophysical implications of planetary studies. The U.S. has available the greatest volume of data on other planets of the solar system, so that the fact that 30 of the 42 papers presented were American comes as no surprise. But, only one from the U.S.S.R. The same points are valid for studies on the middle atmosphere (19 U.S. papers out of 32 and but two from the Soviets).

Where did the Soviets come forth in any measurable numbers? In studies on recent crustal movements, the U.S.S.R. scientists offered six papers versus seven from West Germany, five from India, and four from the U.S. In the symposium "Origin and Nature of the Southern Ocean (Antarctic)," four papers came from the Soviets of a total of 28 (14 from U.S. scientists), and strangely enough, in the session on quantitative methods of assessing plate motions, there were five Soviet papers (versus 16 by the U.S. of the 37 total).

Note that in the above discussion, I have used the words "accepted" and "offered" when referring to the Soviets, meaning that the numbers I have quoted are papers accepted by the respective program committees, but I have no check on those papers actually presented. The only symposia for which that kind of information is in my hands are those scheduled by the International Association for the Physical Sciences of the Ocean (IAPSO). For the 12 IAPSO symposia and four joint IAPSO/IUGG sessions, there were 26 abstracts of Russian papers accepted and scheduled, of which nine were given. This is not unusual, however, as they have responded similarly

at other IUGG assemblies, at the Joint Oceanographic Assemblies (even the 1966 JOA in Moscow), and at other international meetings.

Even had the Soviets not "begged out" of 17 of their proposed papers, their effort would have still been overwhelmed by the 125 U.S. papers (of a total of 254–Appendix II). As it was, they ranked between Japan (13) and India (6) in presentations in physical oceanography.

The papers they did give covered subjects such as:

- Fine structure (A. Aitsam),
- Internal waves in tanks (E. G. Morosov),
- Theory of synoptic-scale ocean currents (A. S. Sarkisyan),
- Synoptic variability of the ocean from hydrographic (ship) data (B. A. Nelepo),
- Mixed layer effects on synoptic variability (V. K. Kosnyrey),
- Scales of variability in the Baltic (A. Aitsam),
- Field observations on the antarctic convergence (A. F. Treshnikov),
- Numerical simulation of the Southern Ocean (V. Guretsky), and
- Tides (E. I. Sarukhanyan).

Those papers not given did not necessarily illuminate any rationale for their absence. They included subjects such as:

- Fine structure of fronts (Fedorov),
- Spectra of wave fields (Moiseev),
- Heat transport of waves (Dvoryaninov),
- Deformation of tsunami waves at the coast (Ivanov),
- Light scattering in the deep sea (Timofeeva),
- *Optics in ocean eddies (Man'kovsky),*
- Vertical transport in the ocean using radioactive tracers (Eremeev),
- Persistence of fronts from satellites (Federov), and
- Numerical model of Lake Baikal.

This is not an inclusive list, yet one can gain an idea of the spread of subjects.

It seems clear from the papers presented in IAPSO that research in physical oceanography by scientists from the western world is alive, well, and highly coordinated. Of the 253 papers, 201 were given by scientists from western Europe, North America, and Australia/New Zealand. Many papers were from cooperative programs, both intra- and inter-national, such as NORPAX, MODE, JASIN, MARSEN, and the like. One cannot avoid the feeling that our understanding of ocean processes has taken a quantum jump in the past decade, made a measurable advance since the last IUGG in Grenoble, France, and that much of this can be attributed to the programs stimulated by the International Decade of Ocean Exploration.

The XVII General Assembly was the first in the southern hemisphere and the first in a location easily accessible to scientists in the Far East. It was an opportunity, therefore, to geophysicists from southeast Asia and the South Pacific to participate in verbal scientific exchange with those from western Europe and America, many probably for the first time. As noted earlier, Australia and New Zealand were well represented, as was Japan. It was interesting, too, that 51 scientists from the People's Republic of China, 14 from Indonesia, and 13 from Thailand were in attendance. Though few gave papers, other than Japanese scientists who are old hands at international gatherings anyway, one would suppose that the exposure was professionally beneficial.

From the papers given by scientists from southeast Asia and the South Pacific, an interesting view comes of the geophysical research efforts in the respective countries. Japan, as one expects, spreads the field for there has been a high-level, sophisticated research effort there for decades. In the interdisciplinary symposia, for example,

papers from Japan covered subjects ranging from rare gases in the earth, the earth's early atmosphere, accretion rates of cosmic material on the earth and Venus, to such esoteric subjects as the air-sea interaction in mesoscale disturbances east of Japan and the reconstruction of crustal plates beneath the Philippine Sea. One interesting series of seven papers was given by Japanese scientists on various aspects of glaciology, a subject not easily addressed in the homeland.

In physical oceanography, the Japanese participants showed a versatility equal to that displayed in the general field of geophysics. Papers were given in microscale turbulence, coastal trapped waves, tsunami convergence in bays, radioactive elements in the Southern Ocean, wind-transported sand, new instrumentation, and the flow of water on the bottom of the deep sea. Such a range met quite well the total span of subjects presented in Canberra, omitting only papers on global models, synoptic ocean scales, and remote sensing–subjects in which the Japanese are already known to have a basic competence.

The papers from Japan, cosmopolitan as they were, contrasted to those from the other countries in the far eastern area. From the People's Republic of China, for example, the two interdisciplinary papers were on broadly philosophic subjects (climate and sea level, and sea-floor spreading) that implied little in the way of either new data or scientific ingenuity. Perhaps it was their way of introducing themselves after a long absence from international scientific meetings.

New Caledonia and Thailand, on the other hand, offered the results of research coming from studies involving the cooperation of other countries. Dr. J. R. Donquy, Noumea, reported on "Hydroclimatic Conditions in the Southwestern Tropical Pacific," an effort that is part of the North Pacific Experiment (NORPAX), funded by ONR and NSF with headquarters at Scripps Institution of Oceanography. The scientists at the Noumea laboratory have cooperated in this program for several years now, and have a close association with the Global Atmospheric Research Program which is coordinated by the World Meteorological Organization.

Similar cooperative studies were described by Professor A. Siripong, Chulalongkorn University, Thailand, on "Surface Circulation in Pang-Noa Bay" using data from the U.S. satellite LANDSAT, and support from two scientists from the University of Tokyo (Murai and Matsuoka). Though the data, and thus the results, were limited, nonetheless, the cooperative efforts indicated a capability of productivity that could solve many coastal oceanography problems in the Thai waters.

From Korea and New Zealand came quite a different view of research, though the sample of but one paper from Korea presents, I suppose, a rather biased picture. Even so, the image from those two countries is of good, solid research done on problems and/or subjects indigenous to the homeland. The one paper from Korea, by Sangbok Hann, was on coastal currents around southeastern Korea.

From New Zealand came a plethora of papers addressing such subjects as Antarctic Ocean fronts (just south of the islands), winter lake snow cover, crustal deformation, and tectonic strain as a model of the New Zealand plate boundary (which bisects the two islands); and volcanic activities such as dust, heat flow, lava genesis, and melting, all on New Zealand volcanoes. The study of strain was accomplished by precise triangulation across the boundary of the Pacific and Indian plates that run north and south through New Zealand (by Bibby) and resulted in a well-founded kinematic model by Walcott. The model and data are sufficiently detailed to permit some extrapolation to other plate-boundary subduction zones.

The work on volcanic activity by Cole and Latter also seemed possible to extrapolate, even though the efforts were on small areas in New Zealand. The anomalous S-wave attenuation beneath active volcanoes, interpreted by Latter as an indication of partial melting, certainly can be applied to other areas. So also would be the work of Pandey on the geothermal gradients in the rocks of New Zealand where the large subsurface generation of heat is well expressed in surface vulcanism, and steam and geyser fields.

APPENDIX I

TOTAL PAPERS ACCEPTED FOR INTERDISCIPLINARY SYMPOSIA

COUNTRY	NUMBER OF PAPERS
United States	213
Australia	51
U.S.S.R.	35
Federal Republic of Germany	31
United Kingdom	28
France	27
Canada	26
Japan	23
India	14
New Zealand	11
Italy	7
Belgium	5
Sweden	5
Switzerland	5
South Africa	4
Egypt	4
German Democratic Republic	3
Argentina	3
Turkey	3
Austria	2
Norway	2
People's Republic of China	2
Finland	1
Denmark	1
Ireland	1
Israel	1
Czechoslovakia	1
Lagos-Nigeria	1
Mexico	1
Netherlands	1
Peru	1
Puerto Rico	1
Pakistan	1
Total	515

APPENDIX II

IAPSO PROGRAM
XVII GENERAL ASSEMBLY IUGG
CANBERRA, AUSTRALIA 1979

COUNTRY	NUMBER OF PAPERS
United States	125
U.S.S.R.	20
Australia	17
Canada	16
France	15
United Kingdom	14
Japan	13
India	6
Norway	3
Federal Republic of Germany	3
New Zealand	3
Denmark	3
Netherlands	2
Egypt	2
South Africa	2
Korea	2
New Caledonia	1
Poland	1
Thailand	1
Kenya	1
Italy	1
Austria	1
Bulgaria	1
Total	253

APPENDIX III

Representative Papers from Japan, Australia, and New Zealand

	Name and Address
– Origin of rare gases in the earth atmosphere	M. Ozima Geophysical Institute University of Tokyo 7-3-1 Hongo, Bunkyo-ku Tokyo 113, Japan, and K. Nakazawa Department of Physics Kyoto University Yoshida-Honcho, Sakyo-ku Kyoto 606, Japan

– Model of early atmospheric composition	Mikio Shimizu Institute of Space and Aeronautical Science University of Tokyo 6-1 Komaba, 4-chome Meguro-ku, Tokyo 153, Japan
– Characteristics of wind in the area near the glaciers in Nepal and the perennial snow patches in Japan	K. Higuchi and T. Ohata Water Research Institute Nagoya University Furo-cho, Chikusa-ku Nagoya 464, Japan
– Relationships between snow distribution and climate in mountain areas	T. Yamada, S. Suizu, H. Nishimura, and G. Wakahama Institute of Low Temperature Science Hokkaido University Sapporo 060, Japan
– Characteristics of mass balance of the glaciers in the eastern part of Nepal Himalayas during summer monsoon season	Y. Ageta Faculty of Education Yamaguchi University Yamaguchi 753, Japan, and T. Ohata, Y. Tanaka, K. Ikegami, and K. Higuchi Water Research Institute Nagoya University Furo-cho, Chikusa-ku Nagoya 464, Japan
– Effects of debris cover on the heat balance of Khumbee Glacier, Nepal Himalayas	O Watanabe, M. Yoshida, H. Fushimi, and K. Higuchi Water Research Institute Nagoya University Furo-cho, Chikusa-ku Nagoya 464, Japan, and J. Inoue Disaster Prevention Research Institute Kyoto University Gokano-sho, Uji-shi Kyoto 611, Japan
– Variations of sea ice conditions in Lutzow-Holm Bay area, Antarctica, in the last twenty years	Kou Kusunoki National Institute of Polar Research 9-10 Kaga, 1-chome Itabashi-ku Tokyo 173, Japan
– Measured and computed temperature profile at Mizuho Station, East Antarctica	F. Nishio and Y. Fujii National Institute of Polar Research 9-10 Kaga, 1-chome Itabashi-ku Tokyo 173, Japan

– Recent fluctuations of glaciers in the eastern part of the Nepal Himalayas	H. Fushimi, T. Ohata, and K. Higuchi Water Research Institute Nagoya University Furo-cho, Chikusa-ku Nagoya 464, Japan
– Fluctuation of climate, glaciers and sea level since late Pleistocene in China	Shi Yafeng Lanzhau Institute of Glaciology and Cryopedology Academia Sinica Beijing, People's Republic of China, and Wang Chingtai Department of Oceanographic Geology Tungsti University Shanghai, People's Republic of China
– Seasonal differences of the circulation processes in a coastal basin nearly closed by land	T. Takahashi Laboratory of Physical Oceanography Faculty of Fisheries Kagoshima University Shimoarata 4-50-20 Kagoshima 890, Japan
– Accretion processes of the earth and Venus	M. Shimizu Institute of Space and Aeronautical Science University of Tokyo 4-6-1 Komaba, Meguro-ku Tokyo 153, Japan
– Geomagnetic consequences of a stratified core model	T. Yukutake Earthquake Research Institute University of Tokyo 7-3-1 Hongo, Bunkyo-ku Tokyo 113, Japan
– Upwelling flow in the earth's mantle and sea floor spreading	Li Yinting and Guan Dexiang Institute of Mechanics Academia Sinica Beijing, People's Republic of China
– System Mg_2SiO_4-MgO-H_2O at high pressures and temperatures–possible hydrous magnesian silicates in the upper mantle and the transition zone	S. Akimoto Institute for Solid State Physics University of Tokyo 7-22-1 Roppongi, Minato-ku Tokyo 106, Japan
– Circulation pattern change over East Asia in the late quaternary period estimated by the distribution of volcanic ash layers	M. Yoshino Institute of Geoscience University of Tsukuba Aza-Amakubo, Ohaza-Tsumaki Sakura-mura, Nihara-gun Ibaraki 300-31, Japan

– Air-sea heat exchanges associated with mesoscale phenomena during Amtex	T. Hayashi and Y. Mitsuta Disaster Prevention Research Institute Kyoto University Gokano-sho, Uji Kyoto 611, Japan, and T. Fujitani Meteorological Research Institute Nogata 1-35-2, Nakano-ku Tokyo 165, Japan
– Similarity regime for wind waves under strong coupling with the wind	M. Tokuda and Y. Toba Geophysical Institute Faculty of Science Tohoku University Sendai, 980, Japan
– Heat transport into active plate boundaries by circulating melt in the athenosphere	Y. Ida Ocean Research Institute University of Tokyo Nakano-ku, Tokyo 164, Japan
– Thermal structure of the Yakedake volcano: Karukaya and Takara geothermal areas	J. Iriyama Department of Natural Sciences Chubu Institute of Technology Kasugai-shi, Aichi 487 Japan
– Reconstruction of the Philippine Sea	S. Uyeda and Y. Matsubara Earthquake Research Institute University of Tokyo 7-3-1 Hongo, Bunkyo-ku Tokyo 113, Japan
– A long-period wave in the tropical mesosphere observed by the Sicamara radar	S. Fukao and T. Sato Department of Electrical Engineering Kyoto University, Kyoto 606, Japan, and I. Hirota Geophysical Institute, Kyoto University Kyoto 606, Japan, and S. Kato Ionospheric Research Laboratory Kyoto University, Gokano-sho, Uji Kyoto 611, Japan
– Wind observations by the Kyoto meteor radar	T. Aso, T. Tsuda, R. Ito, and S. Kato Ionospheric Research Laboratory Kyoto University Gokano-sho, Uji Kyoto 611, Japan
– Progress in planning the middle atmosphere program in Japan	S. Kato Ionospheric Research Laboratory Kyoto University Gokano-sho, Uji Kyoto 611, Japan

– Results of observations of gravity earth tides performed in the South East Asia and their interpretations	K. Hosoyama, S. Nakai, T. Sato, and N. Sata International Latitude Observatory of Mizusawa 2-12 Hoshigaoka, Mizusawa Iwate 023, Japan
– Some facets of oceanic turbulence of microscale	E. Inoue 2-1-4 Tamagawa-Denenchofu Setagaya-ku Tokyo 158, Japan
– Coastal trapped waves in a stratified ocean with continental shelf-slope	N. Suginohara Geophysical Institute University of Tokyo 7-3-1 Hongo, Bunkyo-ku Tokyo 113, Japan
– Topographic upwelling and related microstructure near the shoal Kokusho zone	Y. Nagata and M. Fukasawa Geophysical Institute University of Tokyo 7-3-1 Hongo, Bunkyo-ku Tokyo 113, Japan
– Behaviors of the tsunami and associated seiches in Otsuchi Bay	N. Shikama Otsuchi Marine Research Center Ocean Research Institute University of Tokyo Akama, Otsuchi, Kamihei-gun Iwate 028-11, Japan, and T. Teramoto Ocean Research Institute University of Tokyo 1-15-1 Minamidai, Nakano-ku Tokyo 164, Japan
– A numerical study on effects of seasonal variations in wind and thermal conditions upon subtropical counter-current	K. Takeuchi Ocean Research Institute University of Tokyo 1-15-1 Minamidai, Nakano-ku Tokyo 164, Japan
– Normal and anomalous hydroclimatic conditions in the southwestern tropical Pacific	J. R. Donguy and C. Henin Centre O.R.S.T.O.M. B.P.A. 5, Noumea New Caledonia
– Physical processes of pollutant transport in the inland seas–a review of the researches in the Seto Inland Sea, Japan	H. Nakata and T. Hirano Ocean Research Institute University of Tokyo 1-15-1 Minamidai Nakano-ku, Tokyo 164, Japan

– A study of dissolved metallic elements in the southern ocean waters	Y. Sugimura Meteorological Research Institute 4-35-8 Koenji-kita, Suginami-ku Tokyo 166, Japan, and Y. Miyake and Y. Suzuki Geochemical Research Institute 4-35-8 Koeinji-kita, Suginami-ku Tokyo 166, Japan
– Contents of ^{137}Cs, plutonium and americium isotopes in the southern ocean waters	Y. Miyake Geochemical Research Institute 4-35-8 Koenji-kita, Suginami-ku Tokyo 166, Japan, and K. Saruhashi, Y. Sugimura, T. Kanazawa and K. Hirose Meteorological Research Institute 4-35-8 Koenji-kita, Suginami-ku Tokyo 166, Japan
– Surface circulation pattern at high tide in the north east monsoon season from LANDSAT CCT data and in the southwest monsoon season from the field data at the Pang-Nga Bay, southern Thailand	A. Siripong and S. Dharmvarij Marine Science Department Faculty of Science Chulalongkorn University Bangkok 5, Thailand, and T. Charoendee and S. Tapananond Hydrographic Department Royal Thai Navy Bangkok, Thailand, and S. Murai and R. Matsuoka Institute of Industrial Science University of Tokyo 7-22-1 Roppongi Minato-ku, Tokyo 106, Japan
– Trial manufacture of a new viscometer for sea water *in situ*	N. Fukuchi and T. Abe Department of Physics Science University of Tokyo 1-3 Kagurazaka, Shinjuku-ku Tokyo 162, Japan
– Coastal water movement at Kori Point, southeastern part of Korea	S. D. Hahn Physical Oceanography Laboratory, Korean Ocean Research and Development Institute Korean Institute of Science and Technology Box 131, Dong Dae Mun Seoul 130, Republic of Korea
– Sea surface temperature changes in Korean waters	S. D. Hahn Physical Oceanography Laboratory, Korean Ocean Research and Development Institute Korean Institute of Science and Technology Box 131, Dong Dae Mun Seoul 130, Republic of Korea

– On the transversal seiche motion induced by the Nemuro-Hanto-Oki earthquake	N. Moritani Tokyo Center Japan Weather Association 1-3 Otemachi, Chiyoda-ku Tokyo 100, Japan, and T. Abe Department of Physics Science University of Tokyo 1-3 Kagurazaka, Shinjuku-ku Tokyo 162, Japan
– On the behavior of slicks in open seas and moat waters	T. Abe and H. Takayama Department of Physics Science University of Tokyo 1-3 Kagurazaka, Shinjuku-ku Tokyo 162, Japan
– Sand transport by wind at a reclaimed ground	T. Abe. and M. Arai Department of Physics Science University of Tokyo 1-3 Kagurazaka, Shinjuku-ku Tokyo 162, Japan
– A strong flow concentrated in a bottom layer of the deep open sea	K. Taira and T. Teramoto Ocean Research Institute University of Tokyo 1-15-1 Minamidai, Nakano-ku Tokyo 164, Japan
– Mixing and dissipation by internal wave breaking and fine-scale convection	A. G. McEwan CSIRO Division of Atmospheric Physics Box 77 Mordialloc, Victoria 3195 Australia
– Entrainement at the base of the wind mixed layer	Ian S. F. Jones RAN Research Laboratory P.O. Box 706 Darlinghurst, N.S.W. Australia
– Double diffusive convection with a non-linear equation of state	T. J. MacDougall Research School of Earth Sciences Australian National University P.O. Box 4 Canberra A.C.T. 2600, Australia
– Formation and evolution of well-mixed eddy cores	C. S. Nilsson RAN Research Laboratory Edgecliff 2027, N.S.W. Australia

– Friction at a sheared finger interface	Barry Ruddick Research School of Earth Sciences Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– STEVE: a developmental microstructure profiler	T. G. L. Shirtcliff Physics Department Victoria University Private Bag Wellington 1, New Zealand, and A. E. Gilmour and A. G. Cole New Zealand Oceanographic Institute Box 12346 Wellington, New Zealand
– Crytical layers and the Garrett-Munk spectrum	Barry Ruddick Research School of Earth Sciences Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Mesoscale mixing at the frontal zone between north and south Atlantic central water and its impact on water masses in the canary upwelling area	Matthias Tomczak, Jr. CSIRO Division of Fishery and Oceanography P.O. Box 21 Cronulla, N. S. W. 2230 Australia
– The vertical length scale of double-diffusively driven interleaving at an oceanic front	Barry Ruddick and Stewart Turner CSIRO Division of Fishery and Oceanography P.O. Box 21 Cronulla, N. S. W. 2230 Australia
– Matching initial and boundary data for open ocean models	A. F. Bennett Geophysical Fluid Dynamics Laboratory Monash University Clayton, Victoria 3165 Australia
– The evolution of east Australian eddies	C. S. Nilsson RAN Research Laboratory P.O. Box 706 Darlinghurst, N.S.W. 2010 Australia, and G. R. Cresswell CSIRO Division of Fishery and Oceanography P.O. Box 21 Cronulla, N.S.W. 2230 Australia

– Time variability near the shelf break off the east coasts of South Africa and Australia	Alan Pearce CSIRO Division of Fishery and Oceanography P.O. Box 21 Cronulla, N.S.W. 2230 Australia
– The investigation of the sea surface slope along north-eastern coast of Australia	R. Coleman, C. Rizos, E. G. Master, and B. Hirsch University of New South Wales P.O. Box 1 Kensington, N.S.W. 2033 Australia
– On regional ocean tide recovery using satellite altimetry	E. G. Masters, R. Coleman, and K. Bretreger University of New South Wales P.O. Box 1 Kensington, N.S.W. 2033 Australia
– Role of interfacial process in the transport of atmospheric trace elements to the ocean	K. A. Hunter Department of Chemistry Otago University Box 56 Dunedin, New Zealand
– A study of selected crestal metalliferous sediments from the East Pacific rise	J. H. Johnston and K. E. Knedler Chemistry Department Victoria University of Wellington Private Bag Wellington 1, New Zealand
– Nutrient flushing and circulation in Peel Inlet, Western Australia	Tom Beer Centre for Resource and Environmental Studies Australian National University Canberra A.C.T. 2600 Australia
– Silica diagenesis in Tertiary marine sediments, Southern Australia	J. K. Keene Geology Department University of Melbourne Parkville 3052, Victoria Australia
– Air and water exchange of a non-estuarine gulf	Rainer Radok Horace Lamb Institute of Oceanography Box 167 Kingswood 5062, South Australia Australia
– On estimating the global ocean surface circulation from satellite altimetry	C. Rizos University of New South Wales P.O. Box 1 Kensington, N.S.W. 2033 Australia

– An investigation of a water-level oscillation observed in Moreton Bay, Queensland	P. E. Harding and S. N. Milford Department of Physics University of Queensland St. Lucia, Queensland 4067 Australia
– Seasonal sea-ice studies	W. Mitchell Flinders Institute for Atmospheric and Marine Sciences Flinders University of South Australia Bedford Park South Australia 5042, Australia
– Composition and origin of the earth	A. E. Ringwood Research School of Earth Science Australian National University P.O. Box 4 Canberra, A.C.T. 2600 Australia
– Early biosphere and its significance in interpreting the history of the hydrosphere and atmosphere	M. D. Muir Bureau of Mineral Resources Box 378 Canberra, A.C.T. 2601 Australia
– Evolution of atmospheric oxygen and ozone	J. H. Carver Research School of Physical Science Australian National University Canberra A.C.T. 2600 Australia
– Investigation of the antiquity of sulphate-reducing bacteria based on sulpher isotope studies	T. H. Donnelly and I. B. Lambert CSIRO, Baas Becking Laboratory P.O. Box 378 Canberra A.C.T. 2601 Australia
– Significance of recent sediment studies in the lower proterozoic of Northern Australia with respect to the evolution of the atmosphere of hydrosphere	M. D. Muir, I. H. Crick, and M. R. Walter Bureau of Mineral Resources Box 378 Canberra A.C.T. 2601 Australia
– Effects of snow cover on winter lake cover in a temperate environment	T. D. Prowse Geography Department University of Canterbury Christchurch, New Zealand
– Antarctic sea ice growth and oceanic heat flux	I. Allison, G. Akerman, John Tann, and R. Wills Antarctic Division Department of Science and the Environment 568 St. Kilda Road Melbourne 3004, Australia

B

– Effect of sea-ice extent off Antarctica on the general circulation of the southern hemisphere	I. Simmands Meteorology Department University of Melbourne Parkville 3052, Victoria Australia
– Derivation of past climate changes from observed changes of glaciers	I. N. Smith and W. F. Budd Meteorology Department University of Melbourne Parkville 3052, Victoria Australia
– Growth and retreat of ice sheets in response to orbital radiation changes	W. F. Budd and I. N. Smith Meteorology Department University of Melbourne Parkville 3052, Australia
– Responses of ice-sheets to environmental changes	N. W. Young Antarctic Division Department of Science and Environment 568 St. Kilda Road Melbourne 3004, Australia
– Mass budget studies in East Antarctica	V. L. Morgan and T. Jacka Antarctic Division Department of Science and Environment 568 St. Kilda Road Melbourne 3004, Australia
– Importance of ice sheets in long term changes of sea level and climate	W. F. Budd Meteorology Department University of Melbourne Parkville 3052, Victoria Australia
– Lunar laser Ranging	Peter Morgan Division of National Mapping P.O. Box 548 Queanbeyan, N.S.W. 2620 Australia
– A three-dimensional tidal model for shallow seas	John Noye Department of Applied Mathematics University of Adelaide Adelaide, South Australia 5001 Australia
– Sea ice variations and climate	W. F. Budd Meteorology Department University of Melbourne Parkville 3052, Victoria Australia

– Oceanic fronts in the New Zealand subantarctic region	R. A. Heath New Zealand Ocean Institute Department of Scientific and Industrial Research P.O. Box 12-346 Wellington, New Zealand
– Interlinking of physical and biological processes in the Antarctic Ocean	D. J. Trauter Commonwealth Scientific and Industrial Organization, Australia P.O. Box 21 Cronulla, N.S.W. 2230 Australia
– New results for the angular momentum exchange between the solid earth and atmosphere	K. Lambeck and P. Hopgood Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Deglaciation effects on the rotation of the earth	S. M. Nakiboglu and K. Lambeck Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– A review of the meteorological excitation of polar motion	J. B. Merriam Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
Geochemical constraints on planetary compositions	S. R. Taylor Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Palladium, gold, and iridium in mantle minerals: implications for models of magma genesis	R. H. Mitchell and R. R. Keays Department of Geology University of Melbourne Parkville 3052, Victoria Australia
–Island arc magmatism in relation to the evolution of the mantle and crust	R. J. Arculus Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600, Australia

– Complete determination of local crustal deformation from geodetic observations	W. I. Reilly Geophysics Division Department of Scientific and Industrial Research P.O. Box 1320 Wellington, New Zealand
– Geodetic and tectonic strain axes and rates; geodetic and tectonic moments	G. J. Lenson Earth Deformation Section New Zealand Geological Survey Department of Scientific and Industrial Research P.O. Box 30368 Lower Hutt, New Zealand
– Long term asymmetries in the geomagnetic field and their possible relation to core dynamics	M. W. McElhinny and R. T. Merrill Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Second order elasticity theory and Poisson's ratio of the inner core and lower mantle	A. J. Falzone and F. D. Stacey Department of Physics University of Queensland Brisbane, 4067, New Zealand
– Mineralogy of an eclogitic earth mantle and some remarks on the 200-km seismic discontinuity	Lin-gun Liu Research School of Earth Science Australian National University P.O. Box 4, Canberra A.C.T. 2600 Australia
– High-pressure behavior of the iron oxides	Ian Jackson and A. E. Ringwood Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Velocity discontinuities at depths greater than 650 km	K. J. Muirhead Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Volcanic dust generation and dispersal by volcanic eruptions	G. P. L. Walker Geology Department Auckland University Auckland, New Zealand

– Wave-induced effect on the similarity of Reynolds shear stress and heat flux in the marine surface layer	A. J. Chambers and R. A. Antonia Department of Mechanical Engineering University of Newcastle, N.S.W. 2308 Australia
– Mixed layer dynamics in lakes of small to medium size	R. H. Spigel Department of Civil Engineering University of Canterbury Christchurch, New Zealand, and J. Imberger Department of Civil Engineering University of Western Australia Nedlands 6009, Australia
– Terrestrial heat flow in the North Island of New Zealand	O. P. Pandey Institute of Geophysics Victoria University of Wellington Private Bag Wellington 1, New Zealand
– Evidence for partial melting beneath New Zealand volcanoes from S-wave attenuation	J. H. Latter Geophysics Division Department of Scientific and Industrial Research P.O. Box 1320 Wellington, New Zealand
– Tertiary anorogenic mafic lavas of southern and central Queensland–their mineralogy and petrogenesis, and their role in crustal evolution of Eastern Australia	A. Ewart, K. Boxter, and J. A. Ross Department of Geology University of Queensland St. Lucia, Brisbane Queensland 4067, Australia
– Chemistry and genesis of lavas of taupo volcanic zone, N.Z.	J. W. Cole Geology Department Victoria University of Wellington Private Bag Wellington 1, New Zealand
– Mantle metasomatism by kimberlitic/carbonatitic fluids–precursor to continental alkaline volcanism	Suzanne Y. Wass School Earth Sciences Macquarie University North Ryde, N.S.W. 2113 Australia
– Experimental evidence for the role of accessory phases in magma genesis	T. H. Green School Earth Sciences Macquarie University North Ryde, N.S.W. 2113, Australia
– Hot spots in the southern oceans–an absolute frame of reference for motion of the Gondanan continents	R. A. Duncan University of Tasmania Hobart, Tasmania 7005, Australia

– Pacific/Indian plate boundary zone in New Zealand: geodetic strain	H. M. Bibby Geophysics Division Department of Scientific and Industrial Research P.O. Box 1320 Wellington, New Zealand
– Pacific/Indian plate boundary zone in New Zealand: kinematic model	R. I. Walcott Geophysics Division Department of Scientific and Industrial Research P.O. Box 1320 Wellington, New Zealand
– Plate driving forces at anomaly 23 time	J. F. Harper Department of Mathematics Victoria University of Wellington Private Bag Wellington 1, New Zealand
– Date of formation of Gondwanaland	M. W. McElhinny Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Cambrian paleomagnetic data from southern and central Australia: implications for the unity of the Australian plate and Gondwanaland	C. T. Klootwyk Research School of Earth Science Australian National University P.O. Box 4, Canberra A.C.T. 2600 Australia
– Paleomagnetism of the lower palaeosoic of southeast Australia	B. Goleby Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Paleomagnetism of the Tibetan series, Nepal, Himalaya: implications for the northern extent of greater India	C. T. Clootwyk and D. K. Bingham Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia
– Permian paleointensities: a preliminary study	W. E. Senanayabe Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600 Australia

– In search of the Illawarra reversal	B. J. J. Embleton CSIRO Division of Mineral Physics North Ryde, N.S.W., Australia
– Electrical conductivity from Australian magnetometer arrays using spatial gradient data	F. E. M. Lilley Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600, Australia
– Magnetotelluric depth sounding in the Bowen Basin	D. L. Debber and L. M. Hastie Physics Department University of Queensland St. Lucia, Brisbane, Queensland 4067 Australia
– A relationship between electrical conductivity and creep processes in silicates	B. E. Hobbs Department of Earth Sciences Monash University Clayton, Victoria 3168 Australia
– Magnetometer array studies in India	F. E. M. Lilley Research School of Earth Science Australian National University P.O. Box 4 Canberra A.C.T. 2600, Australia
– Mean sea level and its interpretation	J. S. Godfrey and B. V. Hamon CSIRO Division of Fisheries and Oceanography P.O. Box 21 Cronulla N.S.W. 2230, Australia
– On the recovery of ocean dynamic information from satellite altimetry	R. Coleman University of New South Wales Sydney, Australia
– Discussion of a long series of gravity tide measurements at Alice Springs	Bureau of Mineral Resources Canberra, Australia

KEXUE TONGBAO
(A MONTHLY JOURNAL OF SCIENCE)

Francis A. Richards

The first number of the foreign language edition (actually an English language edition) of *Kexue Tongbao* (a monthly Journal of Science) appeared in January, 1980, as Volume 25, No. 1-2. The issue included 96 pages, 20 articles (listed below), and four technical letters to the editor. The table of contents suggests the wide diversity of subjects covered; they include mathematics, chemistry, physics, astronomy, oceanography, geochemistry, geophysics, hydrology, pharmacology, and acupuncture. The publication is edited by an editorial committee, which consists of a chairman, 11 vice chairmen, and 102 members. The editorial office is at No. 137, Chaoyangmennei Street, Beijing; the journal is published by Science Press, Beijing, and distributed by Guozi Shudian, P.O. Box 399, Beijing. The quoted subscription price is $7.20 per year.

Not only is the editorship in the hands of a committee, but two of the papers included in the number are authored by groups.

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– On accreting black hole model of SS433	Fang Lizhi Remo Ruffini
– Gravitational instability of loosely wound spiral density wave of galaxies–an investigation into stellar dynamics	Xu Jianjun
– A preliminary investigation of cyclonic eddy in north east China Sea in summer	Hu Dunxin Ding Zongxin Xiong Quingcheng
– Study on thermoluminescence of Jilin shower meteors	Pei Jingxian Wang Zaizhung Li Jiliang
– Toxicity and clinical studies on Poly (I): Poly (C)	PIC Research Corp. Group
– A microarea electron diffraction analysis of 69R and 147R polytypes of SiC	Guo Kexin Zhou Jing Wu Yukun
– A study on background values of twelve elements in soils of Beijing and Nanjing	Group on Natural Background Values of Soil
– Alterations of enkephalin contents in brain regions by acupuncture	Zou Gang Yi Qingcheng Wang Fansheng Lu Yixing Zhang Zuxuan Wu Shixiang
– Spontaneous discharges of habenular nucleus and its inhibitory action on nucleus raphe magnus	Wang Shao Jiang Yan Xiao Jiasi Liu Minzhi Liu Suping
– Statistical theory of sediment transport	Han Qiwei He Mingmin

A companion journal, *Scientia Sinica*, is published and distributed by the same organizations and is edited by the same committee. However, *Scientia Sinica* has been published in English since its inception in 1952. It costs $12.50 per year.

INTERNATIONAL MEETINGS IN THE FAR EAST

1980-1983

compiled by Seikoh Sakiyama

It is intended to update and augment this list in future issues of the Scientific Bulletin. The assistance of Dr. T. D. C. Grace, Australian Embassy, Tokyo, and Dr. M. J. McNamara, New Zealand Embasy, Tokyo, in supplying a listing of meetings in their countries is deeply appreciated. Similarly, the assistance of Dr. Robert Stella, American Embassy, Seoul, in supplying a listing of meetings in Korea is deeply appreciated. Readers are asked to notify us of upcoming international meetings in the Far East which have not yet been included in this list.

1980

Date	Title	Site	For information, contact
June 30-July 4	The Eighth International Liquid Crystal Conference	Kyoto, Japan	Prof. Shunsuke Kobayashi, Dept. of Electric Engineering, Faculty of Technology, Tokyo University of Agriculture and Technology, 2-24-16 Nakamachi, Koganei-shi, Tokyo 184
June 30-July 4	The Seventh International Congress on Catalysis	Tokyo, Japan	Prof. I. Yasumori, Dept. of Chemistry Faculty of Science, Tokyo Institute of Technology, 2-12-1, Ookayama Meguro-ku, Tokyo 152
July 7-8	Tenth International Congress on Acoustics	Adelaide, Australia	10 ICA Congress Secretariat, GPO Box 2609, Sydney, NSW, 2001
July 7-11	10th IUPAC International Symposium on Carbohydrate Chemistry	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra, ACT 2601
July 9-16	Australian Acoustical Society "Acoustics in the 1980s"	Sydney, Australia	The Australian Acoustical Society Tenth ICA Executive Committee, The Science Center, 35 Clarence Street Sydney, NSW, 2000
July 19-20	ICA-1980 Associated Acoustics Conference	Auckland, New Zealand	ICA-1980 Associated Conference P.O. Box 1181, Auckland
July 20	10th International Conference on Acoustics	(Undecided) New Zealand	Dr. C. Balachandron, New Zealand Acoustic Society, D.S.I.R. Private bag Lower Hutt

Date	Title	Site	For information, contact
July 20-August 2	The 2nd International Symposia on Biology and Management of Mangroves and Tropical Shallow Water Communities	Port Moresby, Madang, Papua New Guinea	The Western Society of Naturalists Prof. David H. Montgomery, Biological Sciences Department, California Polytechnic State University, San Luis Obispo, California 93407 USA
July 22-25	IAU (International Astronomical Union) Symposium No. 93 "Fundamental Problem in the Theory of Stellar Evolution"	Kyoto, Japan	Prof. D. Sugimoto, Dept. of Earth, Science and Astronomy, University of Tokyo, 3-8-1, Komaba, Meguro-ku Tokyo 153
July 22-29	Vth International Symposium on Biological Control of Weeds	Brisbane, Qld. Australia	CSIRO Div. of Entomology, Private Bag 3, Indooroopilly, QLD. 4068
July 29-30	International Conference on Manufacturing Engineering	Melbourne, Australia	The Institution of Engineers Australia 11 National Circuit, Barton, ACT 2601
August 3-9	XVI International Congress of Entomology	Kyoto, Japan	Kyoto International Conference Hall Takara-ike, Sakyo-ku, Kyoto 606
August 18-22	7th Australasian Hydraulics and Fluid Mechanics Conference	Brisbane, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT, 2600
August 18-22	5th Australian Electrochemistry Conference	Perth. Australia	Professor A. J. Parker, Murdoch University, Murdoch, WA, 6153
August 18-22	4th International Conference on Production Engineering	Tokyo, Japan	The Japan Society of Precision Engineering, Scramikkusu Bldg., 2-22-17 Hyakunin-cho, Shinjuku-ku, Tokyo 160
August 24-31	The 21st Congress of International Association of Theoretical and Applied Limnology	Kyoto, Japan	Assistant Prof. T. Miura, Otsu Hydrobiological Station, Kyoto University Shimosaka-Honmachi, Otsu 520-01
August 25-28	First Asian Seminar on Health and Medical Sociology	Yokohama, Japan	Prof. Mikio Yamamoto, Department of Health, School of Medicine, Teikyo University, 2-11-1, Kaga, Itabashi-ku Tokyo 173
August 25-29	8th Asian Congress of Pharmaceutical Sciences of the Federation of Asian Pharmaceutical Associations	Kyoto, Japan	Japan Pharmaceutical Association 2-12-15-701, Shibuya, Shibuya-ku Tokyo 150
August 25-29	12th Australian Spectroscopy Conference	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT, 2601

Date	Title	Site	For information, contact
August 25-29	4th National Congress, Australian Institute of Physics	Melbourne, Australia	Dr. R. J. Fleming, Dept. of Physics, Monash University, Clayton, Vic. 3052
August 25-29	Symposium on the Mangrove Environment in Asia	Kuala Lumpur, Malaysia	Prof. Ahmad Nawawi, Deputy Vice-Chancellor, University of Malaya Talipon 54361, SMA1, Kuala Lumpur Malaysia
August 25-September 1	The 10th International Cartographic Conference and the 6th General Assembly of the International Cartographic Association	Tokyo, Japan	Mr. K. Nishimura, Japan Map Center Kudan Pompian Building, 8-8, 4-chome, Kudan-Minami, Chiyoda-ku Tokyo 102
August 28-30	WHO/SPEC Official Meeting on Technical Co-operation in Pharmaceutical Supplies	Auckland, New Zealand	NZ Health Department, Wellington
August 31-September 5	General Assembly, the 15th International Geographical Union, and the 24th International Geographical Congress	Tokyo, Japan	Prof. S. Yamamoto, Rissho University 16-2-4, Ohsaki, Shinagawa-ku Tokyo 141
September 1-5	15th International Conference on the Physics of Semiconductors	Kyoto, Japan	Assistant Prof. K. Kamimura, Dept. of Physics, Faculty of Science University of Tokyo, 1-3-7, Hongo Bunkyo-ku, Tokyo 113
September 15-18	International Symposium on Development of the Yellow Sea	Seoul, Korea	Korean Ocean Research and Development Institute, P.O. Box 17, Yang-Jae, Seoul
September 15-19	4th Asian Symposium on Medical Plants and Spices	Bangkok, Thailand	Dr. Vichai Reutrakul, Department of Chemistry, Faculty of Science, Mahidol University, Rama VI Road, Bangkok 4
September 21-28	XXXI Congress of the International Astronautical Federation	Tokyo, Japan	Secretariat, XXXI Congress of the International Astronautical Federation World Trade Center Bldg., P.O. Box No. 12, Hamamatsu-cho 2-4-1 Minato-ku, Tokyo 105
September 22-25	Eighth International Conference on Occupational Health in the Chemical Industry	Tokyo, Japan	Prof. N. Takemura, Jikei University School of Medicine, Minato-ku Tokyo 105
September 22-26	Seventh International Conference on the Use of Computers in Radiation Therapy	Tokyo, Japan	Mr. S. Yazawa, Japan Industries Association of Radiation Apparatus, Omuro-Bldg., 1-6-2, Yushima Bunkyo-ku, Tokyo 113
September 24-27	The 4th International Conference on Magnetic Bubbles (ICMB)	Tokyo, Japan	Prof. H. Kobayashi, Department of Applied Physics, School of Science & Engineering, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo 160

Date	Title	Site	For information, contact
September 26-28	3rd Symposium on Physical and Technical Aspects of Transmission and Emission Computed Tomography	Tokyo, Japan	Mr. S. Yazawa, Japan Industries Association of Radiation Apparatus Omuro-Bldg., 1-6-2, Yushima Bunkyo-ku, Tokyo 113
September (tentative)	Workshop on Specialty Chemical Industry for ROK-ROC Technical Cooperation	Seoul, Korea	Dr. K. Y. Park, Head of Process Development Lab., P.O. Box 131 Dongdaemun, Korea Institute of Science and Technology (KIST) Seoul
September 28-October 2	Symposium 1980 I.A.H.R. (International Association for Hydraulic Research), Section for Hydraulic Machinery Equipment and Cavitation	Tokyo, Japan	Prof. Dr. Masaaki Shirakura, Faculty of Engineering, University of Tokyo 7-3-1, Hongo, Bunkyo-ku, Tokyo 113
September 29-October 3	The 3rd International Conference on Ferrites	Kyoto, Japan	Prof. M. Sugimoto, Dept. of Electronics Faculty of Engineering, Saitama University, 255, Shimo-Ohkubo, Urawa Saitama 338
September 29-October 4	International Conference on Steel Rolling (The Science and Technology of Flat-rolled Products)	Tokyo, Japan	The Iron and Steel Institute of Japan Keidanren Kaikan, 1-9-4, Ohtemachi Chioyoda-ku, Tokyo 100
September 29-October 4	The 3rd World Conference on Medical Information	Tokyo, Japan	Prof. Masamitsu Oshima, MEDINFO 80 Tokyo, P.O. Box 40, Hongo Tokyo 113
September 30-October 4	The 8th International Conference on Computative Linguistic (COLING 80)	Tokyo, Japan	Prof. Makoto Nagao, Department of Electronics Engineering, Faculty of Engineering, Kyoto University Yoshida-Honcho, Sakyo-ku, Kyoto 606
October 1-3	The 10th International Symposium on Fault-Tolerant Computing	Kyoto, Japan	G. S. Mr. Shoji Watanabe, Kokusai Denshin Denwa Co., Ltd., 2-3-2 Nishi-Shinjuku, Shinjuku-ku, Tokyo 160
October 6-9	The 8th World Computer Congress I.F.I.P. (The International Federation for Information Processing) Congress '80	Tokyo, Japan	Information Processing Society of Japan, Kikai Shinko Kaikan, 3-5-8 Shiba-Koen, Minato-ku, Tokyo 105
October 6-10	Thirteenth Symposium on Naval Hydrodynamics	Tokyo, Japan	Prof. Takao Inui, Department of Naval Architecture, Faculty of Engineering University of Tokyo, 7-3-1, Hongo Bunkyo-ku, Tokyo 113
October 8-14	The 12th CODATA General Assembly and the 7th International CODATA Conference	Kyoto, Japan	Prof. T. Shimanouchi, College of Science, Tsukuba University, Saiki Sakura-mura, Niihari-gun, Ibaraki 300-31

1980—Continued

Date	Title	Site	For information, contact
October 12-17	10th World Congress on Metal Finishing (INTERFINISH '80)	Kyoto, Japan	The Metal Finishing Society of Japan Kyodo Bldg., 2, Kanda-Iwamoto-cho Chiyoda-ku, Tokyo 101
October 13-15	1980 International Electrical Research Exchange (IERE) Annual Meeting	Tokyo, Japan	The Japan IERE Council, Central Research Institute of Electric Power Industry, Ohtemachi Bldg., 1-6-1 Ohtemachi, Chiyoda-ku, Tokyo 100
October 13-17	The 6th International Symposium on the Transport of Dangerous Goods by Sea and Inland Waterways	Kyoto, Japan	Japan Marine Surveyors and Sworn Measurer's Association, Kaiji Bldg. 1-9-7, Hatchobori, Chuo-ku, Tokyo 104
October 13-17	Electric Energy Conference	Sydney, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
October 14-17	8th World Computer Congress (International Federation for Information Processing)	Melbourne, Vic. Australia	8th World Computer Congress, P.O. Box 8800, Melbourne, Vic. 3001 (Mr. A. W. Goldsworthy, State Govt. Insurance Office (Qld), Box 1453 G.P.O., Brisbane, QLD. 4001)
October 20-24	Multinational Workshop on Energy Conservation and Alternative Energy	Chung-nam, Korea	Dr. Woong-ki, Kang, President, Korea Energy Research Institute, 45 Mugyo-dong, Chung-ku, Seoul 100
October 20-25	16th Meeting of the Scientific Committee for Antarctic Research (SCAR)	Queenstown, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
October 26-31	The 3rd International Meeting on Radiation Processing	Tokyo, Japan	Research Corporation Section Administration Division, Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute, 1233 Watanukicho Takasaki-shi, Gumma 370-12
October 27-29	International Conference on Welding Research in the 1980's	Osaka, Japan	International Conference Committee Welding Research Institute, Osaka University, Yamada-Kami, Suita Osaka 565
October (tentative)	RACI Cereal Chemistry Div 30th Annual Conference	Melbourne, Australia	Dr. R. A. Orth, Aust. Wheat Board, G.P.O. Box 4562, Melbourne, Vic. 3001

1980—Continued

Date	Title	Site	For information, contact
October (tentative)	Fifth International Conference of Endocrinology	Sydney, Australia	Prof. Brian Hudson, University of Melbourne, Parkville, Vic. 3052
November 2-9	73rd International Conference Federation Aeronautique	Auckland, New Zealand	RNZAC, Trillos
November 3-7	Second Asia and Oceania Congress of Nuclear Medicine	Manila, Philippines	Dr. Flora M. Pascasio, Second AOCNM P.O. Box EA53, Ermita, Manila
November 4-6	Hydrology and Water Resources Symposium	Adelaide, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 10-14	Magneto Hydrodynamic Congress	Adelaide, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 10-21	Xth International Conference on Lighthouses and Other Aids to Navigation	Tokyo, Japan	Navigation Aid Dept., Maritime Safety Agency, 2-1-3, Kasumigaseki, Chiyoda-ku, Tokyo 100
November 11	The First World Congress of International Society of Esophageal Diseases	Tokyo, Japan	Dr. K. Nakayama, Director, Nakayama Cancer Institute, 6-7-19, Ginza, Chuo-ku, Tokyo 104
November 18-20	Microprocessors Conference	Sydney, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 24-28	1st International Conference on Technology for Development	Canberra, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November (tentative)	Geothermal Seminar	Rotorua, New Zealand	NZ Foreign Affairs, Ext. Aid Div. Wellington
December 1-5	4th International Symposium on Nitrogen Fixation	Canberra, Australia	Dr. A. H. Gibson, CSIRO Div of Plant Industry, Box 1600, Canberra, ACT 2601
December 4-5	Lubrication Conference	Melbourne, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600

1981

Date	Title	Site	For information, contact
January 25-31	International Symposium on Erosion and Sediment Transport in Pacific Rim Steeplands	Canterbury, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
January 31-February 4	Conference on Large Earthquakes	Napier, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
February 11-18	International Conference on Soils with Variable Charge	Massey, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
February (tentative)	Fifth International Conference on Ion Beam Analysis	Sydney, Australia	Professor J. C. Kelly, Department of Physics, University of NSW, P.O. Box 1 Kensington, NSW, 2033
March 5-10	1st International Seminar on Semiconductor Processing	Gumi, Korea	Mr. K. B. Whang, Director, Korean Institute of Electronics Technology
March 20-21	The Second International Symposium on Bone, Structure, Function & Disease	Adelaide, Australia	Dr. M. J. Hooper, Royal Adelaide Hospital North Terrace, Adelaide, SA 5000
March (tentative)	Ecotoxicological Problems in the Indo-Pacific Region	Taipei, Taiwan	Dr. Jong-Chin Su, Institute of Zoology Academia Sinica, Taipei 115
April 13-17	International Telecommunications Conference	(undecided) New Zealand	NZ Post Office, Wellington
April 26-May 1	1st Asian and Pacific Chemistry Congress	Singapore, Republic of Singapore	The Congress Secretary, 1st Aspac Congress, Singapore Professional Center 129B Block 23 Ontram Park, Singapore 0316, Republic of Singapore
May 11-15	4th International Conference on Trace Metabolism in Man & Animals (TEMA)	Perth, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
May 11-15	Australian Biochemical Society Annual Meeting	Adelaide, Australia	Dr. H. C. Robinson, Dept. Biochemistry Monash University, Clayton, Vic., 3168
May 23-30	The 12th Conference of the International Association of Ports and Harbors	Nagoya, Japan	Nagoya Port Authority, 1-8-21, Irifune Minato-ku, Nagoya 455
May (tentative)	34th Annual Metals Congress	Sydney, Australia	undecided
May (tentative)	Electric Energy Manufacturing Conference	(undecided) Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600

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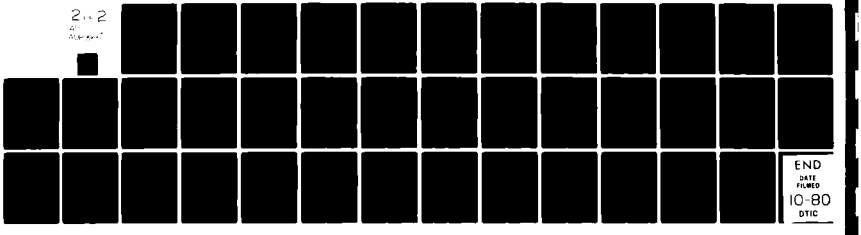

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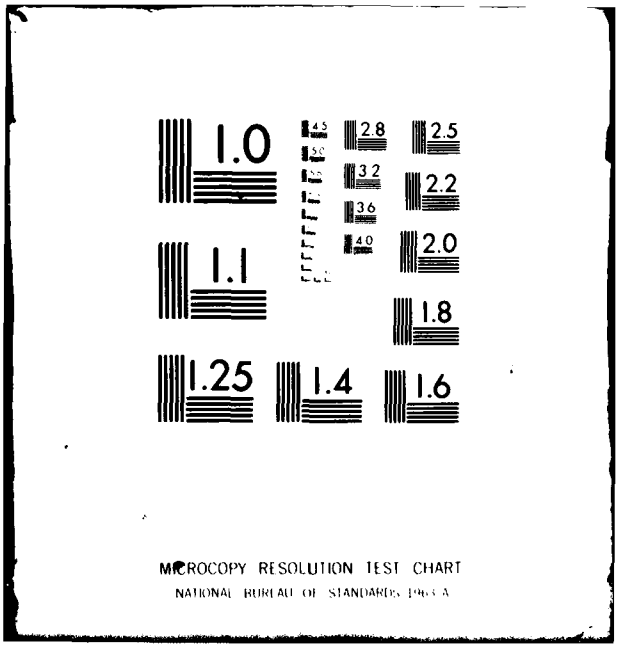
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1981—Continued

Date	Title	Site	For information, contact
June (tentative)	ROK-ROC Seminar on Oceanography	Seoul, Korea	Korea Ocean Research and Development Institute, P.O. Box 17, Yang-Jae, Seoul
July 19-24	8th International Congress of Pharmacology—IUPHAR	Tokyo, Japan	The Japanese Pharmacological Society Gatsukai Center Bldg., 4F., 2-4-16 Yayoi, Bunkyo-ku, Tokyo 113
July 27-August 1	The 4th International Congress of Biorheology	Tokyo, Japan	Japanese Society of Biorheology Physics Laboratory, Keio University 4-1-1, Hiyoshi, Kohoku-ku Yokohama 223
August 10-14	International Congress of Pharmacology	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
August 21-28	XIII International Botanical Congress	Sydney, N.S.W. Australia	Executive Secretary, Dr. W. J. Cram School of Biological Sciences, University of Sydney, N.S.W., 2006
August 24-26	Vth International Conference on Electrical Bio-impedance	Tokyo, Japan	Prof. K. Nakayama, Dept. of Electrical & Electronic Engineering, Sophia University, 7 Kioicho, Chiyoda-ku Tokyo 102
August 24-28	4th International Conference on Rapidly Quenched Metals	Sendai, Japan	The Japan Institute of Metals Aramaki Aoba, Sendai, Miyagi 980
August 24-28	International Federation of Automatic Control (IFAC) 8th Triennial World Congress	Kyoto, Japan	Prof. Y. Sawaragi, Dept. of Applied Mathematics and Physics, Faculty of Engineering, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto 606
August (tentative)	17th Annual Congress of the Australian and New Zealand College of Psychiatrists	Victoria, Australia	(Undecided)
September 1-5	9th ICAS-XXII CSI (9th International Conference on Atomic Spectroscopy and XXII colloquium Spectroscopium Internationale)	Tokyo, Japan	The Japan Society for Analytical Chemistry, 9th ICAS-XXII CSI Gotanda-Sanhaitsu, 26-2, 1-chome Nishi-gotanda, Shinagawa-ku, Tokyo 141
September 12-18	The 10th International Congress of Electroencephalography and Clinical Neurophysiology	Kyoto, (undecided) Japan	International Conference Organizers, Inc. Crescent Plaza 103, 2-4-6, Minami-Aoyama, Minato-ku, Tokyo 107
September 17-21	The 14th World Congress of International League against Epilepsy and the 13th Symposium of the International Bureau for Epilepsy	Kyoto, Japan	International Conference Organizers, Inc. Crescent Plaza 103, 2-4-6, Minami-Aoyama, Minato-ku, Tokyo 107

1981—Continued

Date	Title	Site	For information, contact
September 20-23	1981 International Symposium on Gallium Arsenide and Related Compounds	Kanagawa, Japan	Prof. H. Yanai, Dept. of Electronic Engineering, University of Tokyo 7-3-1, Hongo, Bunkyo-ku, Tokyo 113
September 20-25	12th World Congress of Neurology	Kyoto, Japan	Simul International, Inc., No. 9 Kowa Bldg., 1-8-10, Akasaka, Minato-ku, Tokyo 107
September 23-25	Australasian Society of Nephrology joint meeting with Cardiac Society	Brisbane, Australia	Dr. B. M. Saker, Renal Unit, Royal Perth Hospital, Perth, WA, 6000
September (tentative)	International Rock Mechanics Symposium on Weak Rock—Soft, Fractured and Weathered Rock	Tokyo, Japan	Japan Society of Civil Engineers 1-chome, Yotsuya, Shinjuku-ku Tokyo 160
October 4-7	4th Congress of International Society for Laser Surgery	Tokyo, Japan	Narong Nimsakul, M.D., Secretary General, 4th Congress of International Society for Laser Surgery, Department of Plastic Surgery, School of Medicine Tokai University, Boseidai, Isehara-shi Kanagawa Pref. 259-11
October 7-9	Symposium on Industrial Robots and Robot Exhibit	Tokyo, Japan	Mr. Y. Komori, Japan Industrial Robot Association, Kikai Shinko Bldg., 3-5-8 Shiba-Koen, Minato-ku, Tokyo 105
October 11-23	International Union Conservation of Nature and Natural Resources	Christchurch, New Zealand	Lincoln College, Christchurch
October 18-25	15th Annual Conference on Law of the Sea	Seoul, Korea	Korea Ocean Research and Development Institute, P.O. Box 17, Yang-Jae Seoul
Late October-Early November	FAI the 74th General Conference, 1981 (International Aeronautical Federation)	Tokyo, Japan	Japan Aeronautic Association, 1-18-2 Shimbashi, Minato-ku, Tokyo 107

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May 10-15	General Meeting of the International Association of Geodesy	Tokyo, Japan	Assistant Prof. I. Nakagawa, Geophysical Institute, Faculty of Science Kyoto University, Oiwake-cho, Kita-Shirakawa, Sakyo-ku, Kyoto 606
May 23-28	16th International Congress of Dermatology (CID)	Tokyo, Japan	Japan Convention Services, Inc. Nippon Press Center 8F, 2-2-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
June (tentative)	Twelfth International Conference of Biochemistry	Sydney, Australia	Prof. W. H. Elliot, Biochemistry Department, University of Adelaide, Adelaide, S.A. 5000

1982—Continued

Date	Title	Site	For information, contact
July 5-10	VI International Symposium on Solute–Solute–Solvent Interactions	Osaka, Japan	Prof. H. Ohtaki, Tokyo Institute of Technology at Nagatsuta, Department of Electronic Chemistry, Nagatsuta Midori-ku, Yokohama 227
Mid-July (tentative)	The 5th International Congress of Plant Tissue	Yamanashi, Japan	Assistant Prof. A. Komamine, Dept. of Botany, Faculty of Science University of Tokyo, 7-3-1, Hongo Bunkyo-ku, Tokyo 113
August 9-September 3	The 5th International Congress of Pesticide Chemistry, IUPAC	Kyoto, Japan	Rikagaku Kenkyusho, 2-1, Hirosawa Wako, Saitama 351
August 15-21	International Biochemical Congress	Perth, Australia	Australian Academy of Science and International Union of Biochemistry P.O. Box 783, Canberra, ACT 2601
August 22-27	Fourth International Conference on Organic Synthesis (IUPAC)	Tokyo, Japan	Prof. T. Mukaiyama, Department of Chemistry, Faculty of Science, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113
August (tentative)	The Royal Australian Chemical Institute 7th National Convention	Canberra, Australia	Executive Secretary, RACI HQ 191 Royal Parade, Parkville, Vic. 3052
August (tentative)	13th Australian Spectroscopy Conference	(undecided) Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
August (tentative)	1982 International Conference on Solid State Devices	Tokyo, Japan	The Japan Society of Applied Physics Kikai-Shinko-Kaikan, 5-8, 3-chome Shibakoen, Minato-ku, Tokyo 105
August (tentative)	International Biochemistry Congress	Perth, W.A. Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
Late August (tentative)	The 8th Triennial Congress of the International Ergonomics Association	Tokyo, Japan	Prof. M. Oshima, Medical Information Systems, Development Center, Akasaka Park Bldg., 2-3-4, Akasaka, Minato-ku Tokyo 107
September 5-10	International Conference on Magnetism–1982 (ICM–1982)	Kyoto, Japan	Prof. J. Kanamori, Faculty of Science Osaka University, Toyonaka, Osaka Pref. 560
September 6-10	International Conference on Nuclear Physics in the Cyclotron Energy Region	Osaka, Japan	Prof. M. Kondo, Research Center for Nuclear Physics, Osaka University Yamada-kami, Suita-shi, Osaka Pref. 565

1982—Continued

Date	Title	Site	For information, contact
September (tentative)	6th International Symposium on Contamination Control	Tokyo, Japan	Japan Air Cleaning Association 6-7-5, Soto-Kanda, Chiyoda-ku Tokyo 101
October 4-6	Third International Dental Congress on Modern Pain Control	Tokyo, Japan	Japan Convention Service, Inc. Nippon Press Center 8F., 2-2-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
Undecided	International Conference on Mass Spectroscopy	Hawaii, U.S.A.	Prof. T. Tsuchiya, Basic Science Lecture Room, Chiba Institute of Technology, 1-17-2, Tsudanuma Narashino, Chiba 275
Undecided	International Rehabilitation Medicine Association Fourth World Congress	Sydney, Australia	Prof. G. G. Burniston, Department of Rehabilitation Medicine, Prince Henry Hospital, Little Bay, N.S.W. 2036
Undecided	Workshop on Marine Microbiology	Seoul, Korea	Korea Ocean Research and Development Institute, P.O. Box 17, Yang-Jae Seoul

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May 10-12	Royal Australian College of Physicians ASM	Sydney, Australia	RACP, 145 Macquarie Street, Sydney NSW, 2000
May (tentative)	52nd ANZAAS Conference	Perth, Australia	Dr. G. Chandler, University of Western Australia, Nedlands, W.A. 6009
August 1-7	International Association for Dental Research	Sydney, Australia	Mr. Scott Gotjamanos, Department of Pathology, Perth Medical Centre Verdon Street, Nedlands, W.A. 6009
August 17-24	Fourth International Congress of Plant Pathology	Melbourne, Australia	Mr. B. Price, Victorian Plant Research Institute, Department of Agriculture Victoria, Swan Street, Burnley, Vic. 3121
August 27-31	Twenty-fifth International Geographical Congress	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
August 28-September 2	29th International Congress of Physiology	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
August 28-September 3	The 3rd International Mycological Congress (IMC 3)	Tokyo, Japan	Prof. K. Tsubaki, Institute of Biological Sciences, The University of Tsukuba Sakura-mura, Ibaraki Pref. 305

1983—Continued

Date	Title	Site	For information, contact
August 29-September 2	International Union of Physiological Sciences Congress	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601
August (tentative)	International Solar Energy Congress	Perth, Australia	Mr. P. Driver, Honorary Secretary, P.O. Box 123, Nedlands, W.A. 6009
October (tentative)	8th International Conference on Calcium Regulating Hormone	(Kobe), (tentative) Japan	Prof. T. Fujita, 3rd Division, Dept. of Medicine, School of Medicine, Kobe University, 7-13, Kusunoki-cho Ikuta-ku, Kobe 650
October 29-November 3	71st FDI Annual World Dental Congress (Federation Dentaire Internationale)	Tokyo, Japan	Japan Dental Association (Japanese Association for Dental Science), 4-1-20 Kudan-kita, Chiyoda-ku, Tokyo 102
Undecided	Thirteenth International Congress of Chemotherapy	Melbourne, Australia	Dr. B. Stratford, St. Vincent's Hospital 59 Victoria Parade, Fitzroy, Vic. 3065

INTERNATIONAL CONFERENCE ON TROPICAL CYCLONES

Rudolph J. Marcus

An international conference on tropical cyclones was held 25-29 November 1979, in Perth, Western Australia. Although no one from ONR/Tokyo was at this meeting, the abstracts of papers given at this meeting are available at this office and specific ones can be sent to those who request them.

The sessions at this meeting were devoted to

Socio-economic factors
World Meteorological Organization's tropical cyclones
Artificial modification
Observational aspects
Modeling
Operational forecasting
Boundary layer and moist convection

A listing of speakers at this meeting, their addresses, and titles of their papers follows.

Name and Address	Title
– Robert L. Southern Bureau of Meteorology, DSE Perth, Western Australia Australia	The global socio-economic impact of tropical cyclones
– Robert C. Sheets National Hurricane and Experimental Meteorology Laboratory Environmental Research Laboratories National Oceanic and Atmospheric Administration Coral Gables, FL 33134 U.S.A.	Hurricane modification: its evolution, present state, and future plans
– Ray Jay Davis College of Law University of Arizona Tucson, AZ 85721 U.S.A.	Modification of tropical cyclones: intergovernmental liability arrangements
– Ernst Willheim Attorney Generals Department Canberra, ACT Australia	Legal aspects of artificial cyclone modification

– William M. Gray
Department of Atmospheric Science
Colorado State University
Ft. Collins, CO 80521
U.S.A.

Survey of observational inferences concerning the occurrence, structure, and dynamics of tropical cyclones

– John L. McBride
Australian Numerical Meteorology
Research Center
Melbourne, Victoria
Australia

Budget analysis of tropical cyclone formation

– Wang Zuo-shu, Ding Yi-hui, and He Shi-xiu
Institute of Atmospheric Physics
Academia Sinica, Beijing
People's Republic of China

Some synoptic studies on the formation of typhoon over the northwestern Pacific

– William M. Frank
Environmental Science Department
University of Virginia
Charlottesville, VA 22904
U.S.A.

The effects of tropical cyclones upon larger scale circulations

– Frederick E. Brennan and
Dayton G. Vincent
Department of Geosciences
Purdue University
West Lafayette, IN 47906
U.S.A.

Kinematic, zonal and eddy components of large-scale energy budgets during intensification of hurricane Carmen (1974)

– Greg J. Holland and Thomas D. Deenan
Bureau of Meteorology
DSE, Melbourne, Victoria
Australia, and
Robert C. Sheets
National Hurricane and
Experimental Meteorology
Laboratory, NOAA,
Coral Gables, FL 33134
U.S.A.

Tropical cyclone Kerry: A case study

– Stuart J. Anderson
Defense Research Center
Salisbury, South Australia
Australia

The remote sensing of tropical meteorological and oceanographic phenomena by over-the-horizon radar

– Rex Falls
Bureau of Meteorology
DSE, Darwin, NT
Australia

Cyclone Rosa–another "difficult" gulf storm

– A. H. Gordon
School of Earth Sciences
Flinders University of South Australia
Adelaide, South Australia
Australia

Spectral peaks in the frequencies of tropical cyclones

– Derek Milton
University of Manitoba
Canada

Variations in the frequency of tropical cyclones affecting western Australia–a question of the nature of the climatic change

– D. N. Dhar, P. R. Rakhecha, and B. N. Mandal
Indian Institute of Tropical Meteorology
Poona-5, India

Monsoon rainfall of India and frequency of tropical disturbances

– Shri V. Balasubramaniam and N. Jayanthi
Regional Meteorological Center
Madras, India

Interaction between two cyclones of November 1977 over Indian seas

– Dayton G. Vincent and Phillip J. Smith
Department of Geosciences
Purdue University
West Lafayette, IN 47906
U.S.A.

A diagnostic evaluation of some long-lived tropical cyclones over the United States

– Peter G. Black
National Hurricane and Experimental Meteorological Laboratory
Environmental Research Laboratories
National Oceanic and Atmospheric Administration
Coral Gables, FL 33134
U.S.A.

Recent observations of sea surface cooling caused by tropical cyclones

– A Chowdhury and S. D. Gaikwad
Meteorological Office
Poona-5, India

Three-dimensional structure of monsoon depression and associated rainfall pattern

– M. G. Hamilton
University of Birmingham
England

Unusual behaviour of summer monsoon disturbances over Southern Asia

– A. K. Mukherjee and D. V. Subramanian
Regional Meteorological Center
Colaba, Bombay-5
India

Trochoidal motion of a tropical storm over Arabian sea

– Greg J. Holland and Thomas D. Keenan
Bureau of Meteorology, DSE
Melbourne, Victoria, Australia

Forecasting tropical cyclone movement using time-averaged wind fields

– Jenny M. Hopwood Department of Mathematics University of W. A. Nedlands Western Australia, Australia	Movement forecasting by vorticity method
– Peter J. R. Shaw Bureau of Meteorology, DSE Melbourne, Victoria Australia	Maximum gust recorder
– Gerhard Berz Munchener Ruckversicherungs Gesellschaft Munich, West Germany	World map of natural hazards
– Sally Leivesley International Disaster Institute London, England	The social consequences of Australian cyclone disasters: Implications for planning
– Peter E. Dexter and A. Bruce Neal Bureau of Meteorology, DSE Melbourne, Victoria Australia	A tropical cyclone severity index and its application in the Australian region
– P. K. Misra Area Cyclone Warning Center Regional Meteorological Center Colaba, Bombay-400 005 India	On the feasibility of occurrence of a concentric anticyclone at the center of a cyclone
– Chris M. L. Dorman Department of Housing and Construction Hawthorn, Victoria Australia	Validation of tropical cyclone model
– Lloyd J. Shapiro National Hurricane and Experimental Meteorological Laboratory NOAA, Coral Gables FL 33146 U.S.A.	The role of nonlinearities in the development of easterly waves
– John L. McBride Australian Numerical Meteorology Research Center Melbourne, Vic., Australia	Forecasting tropical cyclone genesis by consideration of patterns of vertical wind shear
– Robert Lourensz Bureau of Meteorology, DSE Melbourne, Victoria Australia, and Alan Scott Bureau of Meteorology, DSE Perth, Western Australia, Australia	A climatological aid to forecasting tropical cyclone movement

– Rangarao V. Madala
Naval Research Laboratory
Washington, D.C. 20375
U.S.A., and
R. Hodur
Naval Environmental Prediction
Research Facility
Monterey, CA 93940
U.S.A.

Real data forecasts with the NRL tropical cyclone model

– F. A. Lajoie and I. Butterworth
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

A study of black-body temperatures of cloud tops around tropical cyclones in the Australian region

– Jorg Imberger, John C. Patterson,
and William J. Wiebe
Department of Civil Engineering
University of Western Australia
Nedlands, West Australia
Australia

Tropical cyclones: nature's ploughs on the North West shelf of Australia

– Tom Beer
Center for Resource and Environmental
Studies
Australian National University
Canberra, A.C.T.
Australia

Tropical cyclone rainfall prediction based on satellite microwave and infra-red data

– V. Kastalsky
Department of Theoretical Physics
University of New South Wales
N.S.W., Australia

Tropical cyclone modification–two propositions

– William K. Downey
Australian Numerical Meteorology
Research Center
Melbourne, Victoria
Australia

Cyclone Wanda and the Brisbane floods of 1974–implications for cyclone modification programs

– Richard A. Anthes
The Pennsylvania State University
University Park, PA 16802
U.S.A.

Modeling of tropical cyclones and their environment

– Robert W. Jones
National Hurricane and Experimental
Meteorology Laboratory
Environmental Research Laboratories
NOAA, Coral Gables
FL 33134, U.S.A.

A model hurricane simulation with a basic current and latent heating by the resolvable scales

– R. P. Pearce
Department of Meteorology
University of Reading
Berks, England

A model of tropical-cyclone intensification based on a similarity theory of the development of an area of deep cumulus convection

– Gordon Bell
Royal Observatory
Hong Kong

Operational forecasting of tropical cyclones: A brief review

– Vernon F. Dvorak
National Environmental Satellite Service
National Oceanic and Atmospheric Administration
Washington, D.C. 20235
U.S.A.

Tropical cyclone analysis using satellite enhanced infrared or "VIS" imagery

– John W. Diercks
Joint Typhoon Warning Center
U.S. Navy Fleet Weather Central
Nimitz Hill, Guam

The 1978 and 1979 tropical cyclone seasons in review

– Wei Ding Wen
Institute of Atmospheric Physics
Academia Sinica
China

Studies on tropical storm by experimental simulation in the laboratory

– Eric K. Webb
CSIRO Division of Atmospheric Physics
Aspendale, Victoria
Australia

Hurricanes and Whirlwinds: Similarities and differences

– Huw C. Davies and Rodolfo A. De Guzman
Department of Meteorology
University of Reading
Berkshire
England

On the vertical partitioning of the diabatic heating and hurricane growth

– F. H. Nicholson
Science Applications, Inc.
Monterey, CA 93940
U.S.A.

The structure of the typhoon in terms of the zero Laplacian vortex

– Frederick Sanders
Department of Meteorology
Massachusetts Institute of Technology
Cambridge, MA 02139
U.S.A.

Operational barotropic prediction of tracks of tropical storms

– John L. McGregor
Australian Numerical Meteorology Research Center
Melbourne, Victoria, Australia

A cyclone trace prediction method using a primitive equation model

– T. D. Keenan and F. Woodcock
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

A combined analogic and synoptic pattern recognition approach to the prediction of tropical cyclone movement

– Russell L. Elsberry and Dennis R. Frill
Department of Meteorology
Naval Postgraduate School
Monterey, CA 93940
U.S.A.

Statistical adjustment of dynamical tropical cyclone model track forecasts

– Angus D. McEwan
Division of Atmospheric Physics
CSIRO, Aspendale, Victoria
Australia

Convection as a kinematic element in tropical cyclone formation

– Edward J. Zipser
National Center for Atmospheric Research
Boulder, CO 80303
U.S.A.

Structure of rainbands observed in GATE and their possible relationships to rainbands in tropical cyclones

– Tom Beer
Center for Resource and Environmental Studies
Australian National University
Canberra, A.C.T.
Australia

Tropical cyclone cloudband kinematics

– Stan A. Stroud
R. K. Steedman & Associates
Consulting Oceanographers and Engineers
Perth, Western Australia
Australia

Tropical cyclone wind field modelling: Scale and maximum wind radii

– Lloyd J. Shapiro
National Hurricane and Experimental Meteorology Laboratory
NOAA, Coral Gables, FL 33134
U.S.A.

A criterion for the development of tropical storms from easterly waves: Physical hypothesis and tests of skill

– Robert W. Burpee
National Hurricane and Experimental Meteorology Laboratory
Environmental Research Laboratories
NOAA, Coral Gables, FL 33134
U.S.A.

The structure of easterly waves during GATE

– Jurl Kuuse
Bureau of Meteorology, DSE
Perth, Western Australia
Australia

Statistical-synoptic prediction of tropical cyclone motion in the Australian region

– France A. Lajoie
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

Predicting tropical cyclone direction of movement using satellite measured equivalent black-body temperatures of cloud tops

– Robert Simpson
University of Virginia
Charlottesville, VA 22904
U.S.A.

The impact of tropical cyclone winds

– Robert H. Leicester and F. D. Beresford
Division of Building Research
CSIRO, Highett, Victoria
Australia, and
Charles T. J. Bubb and Chris M. L. Dorman
Department of Housing and Construction
Hawthorn, Victoria
Australia

Potential cyclone damage to dwellings in Australia

– Joseph E. Minor
Institute for Disaster Research
Texas Tech University
Lubbock TX 79409
U.S.A.

The economics of preparing buildings for tropical cyclone winds

– R. A. Wittenoom
R. A. Wittenoom and Associates
Perth, Western Australia
Australia

The engineered community Western Australia's response to the tropical cyclone

– Michael Garstang
University of Virginia
Department of Environmental Sciences
Charlottesville, VA 22903
U.S.A.

The tropical atmospheric boundary layer: Structure and transports

– Ken J. Wilson
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

Characteristics of the subcloud layer wind structure in tropical cyclones

– J. L. Redelsperger and G. Sommeria
Centre Nationale De La Recherche Scientifique
Paris, France

Parameterization of sub-grid scale turbulent processes in a three-dimensional model for precipitating moist convection

– Peter G. Black and Mark Powell
National Hurricane and Experimental Meteorology Laboratory
Environmental Research Laboratories
NOAA, Coral Gables, FL 33134, U.S.A., and

Boundary layer fluxes in cyclone Kerry

Greg J. Holland
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

– William M. Gray
Department of Atmospheric Science
Colorado State University
Ft. Collins, CO 80521
U.S.A.

Tropical cyclone motion research–a proposed methodology

– Charles R. Holliday
Air Force Global Weather Central
Offutt AFB, NE 68113
U.S.A., and
Aylmer H. Thompson
Texas A&M University
College Station, TX 77840
U.S.A.

On paths and seasonal–geographic characteristics of rapidly intensifying typhoons

– C. G. Revell
New Zealand Meteorological Service
Wellington, New Zealand

Tracks of tropical cyclones in the Southwest Pacific

– Tao Shih-Yen and He Shih-Xiu
Institute of Atmospheric Physics
Academia Sinica, and
Yang Zsu-Fang
Central Meteorological Bureau of China

Association of tropical cyclone activities in the Western Pacific with large-scale circulation in the Southern and Northern hemisphere

– A. K. Mukherjee, B. Shyamala and K. P. Padmanabhan
Regional Meteorological Center
Bombay, India

Cross equatorial flow and consequent interaction between tropical cyclones occurring on either side of the equator

– Paul J. Hebert
National Hurricane Center
NOAA, Coral Gables, FL 33134
U.S.A.

The worldwide problem of a severe tropical cyclone experience–or lack of it

– M. Aminul Islam
Department of Geogrpahy
University of Dacca
Bangladesh

Cyclone hazards in Bangladesh: Perception and adjustment

– John P. Dawson
Insurance Council of Australia
Melbourne, Victoria
Australia

Socio-economic aspects of cyclones related to insurance

– Joe Gentilli
University of Western Australia
Nedlands, Western Australia, Australia

Cyclone Alby, the 10^8 to 1 outsider

– Kevin P. Stark and George R. Walker Department of Civil and Systems Engineering James Cook University of North Queensland Townsville, Queensland Australia	Simulation of evacuation for cyclone and storm surge
– Gordon Bell Royal Observatory Hong Kong	Some studies of tropical cyclone movement
– Andrew W. Garcia U.S. Army Engineers Waterways Experiment Station Vicksburg, MS 39180 U.S.A.	A comprehensive storm surge prototype data collection program
– P. K. Misra Cyclone Warning Center Regional Meteorological Center Bombay-400 005 India	On the mechanism of development of cyclonic storms
– Derek Milton University of Manitoba Canada	The formation of tropical cyclones in the Western Australian region–a synoptic approach
– I. Subbaramayya Andhra University India, and S. Fujiwara Meteorological Research Institute 35-8, Koenji-kita 4-chome Suginami-ku, Tokyo 166 Japan	On the maximum wind and central pressure in tropical cyclones
– Phillip J. Meighen Bureau of Meteorology, DSE Melbourne, Victoria Australia	Estimation of low level winds in tropical cyclones from observations of radar echo speeds
– O. N. Dhar, P. R. Rakhecha and A. K. Kulkarni Indian Institute of Tropical Meteorology Poona-5, India	Greatest areal rain depths obtained in tropical disturbances over India
– Malcome R. Kennedy and Terry L. Hart Bureau of Meteorology, DSE Melbourne, Victoria Australia	The application of a generalised method for estimating estimating the probable maximum precipitation from tropical cyclones over Australia

– S. Raghavan and V. M. Varadarajan
Regional Meteorological Center
Madras, India

Radar estimate of rainfall and latent heat release in tropical cyclones of the Bay of Bengal

– Mal L. Heron and James F. Ward
Physics Department
James Cook University of North Queensland
Townsville, Queensland
Australia

Electrodynamics of tropical cyclones

– Stanley L. Rosenthal
National Hurricane and Experimental Laboratory
Environmental Research Laboratories
NOAA, Coral Gables, FL 33134
U.S.A.

A brief history of modeling techniques used to represent the release of latent heat in numerical models of tropical cyclones

– Rangarao V. Madala
Naval Research Laboratory
Washington, D.C. 20375
U.S.A., and
Simon W. Chang
JAYCOR 205, Whiting Street
Alexandria, VA 22304
U.S.A.

The Naval Research Laboratory three dimensional tropical cyclone model

– Katsuyuki V. Ooyama
National Center for Atmospheric Research
NOAA, Boulder, CO 80303
U.S.A.

A quasi-spectral approach to grid-nesting

– D. R. Johnson
The University of Wisconsin
Madison, WI 53706
U.S.A.

Angular momentum and energy balance of the tropical cyclone

– Neil L. Frank
National Hurricane Center
NOAA, Coral Gables, FL 33134
U.S.A.

A hurricane warning office in the 1980's

– Charles J. Neumann
National Hurricane Center
NOAA, Coral Gables, FL 33134
U.S.A.

Some disturbing trends in the accuracy of tropical cyclone forecasts

– Robert C. Sheets
National Hurricane and Experimental Meteorology Laboratory
Environmental Research Laboratories
NOAA, Coral Gables, FL 33134, U.S.A., and

On the structure of cyclone Kerry as revealed by research aircraft penetrations and satellite observations

Greg J. Holland
Bureau of Meteorology, DSE
Melbourne, Victoria
Australia

– Kenji Shimada
Meterological Satellite Center (JMA)
3-235, Nakakiyoto
Kiyose-shi, Tokyo 180-04
Japan

Estimation of the location of typhoon center based on digital IR data on Japanese GMS

– R. Cecil Gentry
Clemson University
Clemson, SC 29631
U.S.A., and
Edward Rodgers
Goddard Space Flight Center
NASA, Greenbelt, MD 20770
U.S.A., and
Joseph Steranka and William E. Shenk
General Electrics Space Division
U.S.A.

Equivalent blackbody temperatures of cloud tops related to maximum winds in tropical cyclones

– Joanne and Robert Simpson
University of Virginia
Charlottesville, VA 22904
U.S.A.

Tropical storm moderation concepts and their testing

– Roger K. Smith
Department of Mathematics
Monash University
Clayton, Victoria
Australia

Tropical cyclone eye dynamics

– N. Fukuta
Department of Meteorology
University of Utah
Salt Lake City, UT 84112
U.S.A.

Microphysics-dynamics interactions in seeded tropical cyclones and hypotheses of their modification

THE 14TH JAPAN CONFERENCE ON RADIOISOTOPES

Rudolph J. Marcus

An international symposium on radioisotopes was held 20-21 November 1979 in Tokyo. Although no one from ONR/Tokyo was at this meeting, the abstracts of papers given at this meeting are available at this office and specific ones can be sent to those who request them.

The sessions at this meeting were devoted to

Recent progress and future of application of isotopes and radiation
Food irradiation
Nuclear instruments and measurement
Economical effects and usefulness of industrial application
Radiation safety and contaminated waste management
International cooperation
Key issues for promotion and potentiality of new application of isotopes and radiation
Accelerator development and its future prospects
Industrialization of radiation processing

A listing of speakers at this meeting, their addresses, and titles of their papers follows.

Name and Address	Title
– Hidetake Kakihana Deputy Director General Department of Research and Isotopes International Atomic Energy Agency Kaerntner Ring 11 P.O. Box 590 A-1011 Vienna, Austria	International cooperation and the IAEA
– J. G. Clouston Chief, Isotope Division The Research Establishment Australian Atomic Energy Commission Private Mail Bag Sutherland 2232, N.S.W. Australia	Radioisotopes in Australia
– R. G. Desphande Head, Isotope Group Bhabha Atomic Research Center Trombay, Bombay 400 085 India	Recent developments and future prospects of radio-isotopes

– Xiao Lun Radioisotope Division Institute of Atomic Energy Chinese Academy of Sciences P.O. Box 775, Beijing The People's Republic of China	Twenty years of radioisotope production from the Institute of Atomic Energy Reactors
– A. S. Shtan Director, The State Scientific Research Institute of Radiation Technology Moscow, U.S.S.R.	Present status and prospects of application of radioisotopes and radiation in U.S.S.R.
– Sadataka Mukoyama Toray Industries, Inc. 2-2, Nihonbashi-Muromachi Chuo-ku, Tokyo 103 Japan	Present status and problems on the applications of radioisotopes and ionizing radiation in Japan
– P. S. Elias International Food Irradiation Project Postfach 3640 D-7500 Karlsruhe F. R. Germany	Wholesomeness studies in the International Food Irradiation Project
– Osamu Yura Radioactivity and High Energy Radiation Section Quantum Technology Division Electrotechnical Lab. 5-4-1, Mukohdai-cho Tanashi-shi, Tokyo 188 Japan	Standardization of environmental radioactivity measuring technique
– Hiroo Sato Nuclear Instruments Engineering Division Aloka Co., Ltd. 6-22-1, Mure, Mitaka-shi Tokyo 181, Japan	Measuring techniques of low energy and low dose radiation
– Tetsuo Sumi Aichi Institute of Technology 303 Suizen Bldg. 2-285-1, Fujimori, Meito-ku Nagoya, Aichi-ken 465 Japan	Some comments on the standardization and radiation safety of nuclear gauges
– V. S. Akopov The State Scientific Research Institute of Radiation Technology Moscow, U.S.S.R.	Radioisotope-equipped defectscopy used for nuclear power plants

– Masao Takahashi
R&D Strategy Planning Department
Toray Industries, Inc.
2-2, Nihonbashi-Muromachi
Chuo-ku, Tokyo 103
Japan

The economics of electron beam irradiation processes

– Toshio Tani
Japan Radioisotope Irradiation
Service Corp.
Ohgaki, Ka-machi
Shimota-gun, Tochigi 328-01
Japan

Cost effectiveness of the gamma irradiation process

– Hiroshi Tominaga
Application and Development Section
Radioisotope Center
Japan Atomic Energy Research Institute
3607, Shimbori, Narita-cho
Higashi-Ibaraki-gun
Ibaraki 311-13, Japan

Radioisotope gauges—results of the nationwide inquiry on the actual condition concerning the economic effects in industrial firms

– Hiro Amano
Plant Engineering Office
Kimitsu Works
Nippon Steel Corp.
1, Kimitsu, Kimitsu-shi
Chiba 299-11, Japan

Utility estimation of instruments using isotope in the steel industry

– Otamaru Sato
Institute of Industrial Science
University of Tokyo
7-22-1, Roppongi, Minato-ku
Tokyo 106, Japan

Assessment of the radioisotope applications to consumer product

– Isao Sonehara
Development Center
Hochiki Corp.
246, Tsuruma, Machida-shi
Tokyo 194, Japan

Benefits from ionization smoke detectors

– Hideo Ueda
Central Hospital of Japan National
Railway
2-1-3, Yoyogi, Shibuya-ku
Tokyo 151, Japan

The radionuclide waste disposal in Japanese hospital

– Koji Kakihara
Tokyo Nuclear Services Co., Ltd.
Kunii Bldg., 6F
3-10-9, Ueno, Taito-ku
Tokyo 110, Japan

Practical situations of the radiation safety control in the radioisotopes utilizing facilities

– Xu Guan-ren The Institute for Application of Atomic Energy in Agriculture Chinese Academy of Agricultural Sciences P.O. Box No. 5109, Beijing The People's Republic of China	Application of atomic energy in agriculture in China
– R. L. Malnati Burlington Operations High Voltage Engineering Corp. Burlington, MA 01803, U.S.A.	Current status of accelerator application in U.S.A.
– Akiji Maekawa Energy Research Laboratory Hitachi, Ltd. 1168, Moriyama-cho, Hitachi Ibaraki 316, Japan	Particle accelerators in Japan
– Masaaki Hazue Technical Department Nihon Medi-Physics Co., Ltd. 4-2-1, Takatsukasa Takarazuka, Hyogo 665 Japan	The present situation and the future development of the cyclotron for the production of radioisotopes
– Masaaki Iio Nakano National Chest Hospital 3-14-20, Ekota Kakano-ku, Tokyo 165 Japan	Clinical use of short-lived radioisotopes by baby cyclotron
– Louis Rosen LAMPF Los Alamos Scientific Lab. P.O. Box 1663 Los Alamos, NM 87545 U.S.A.	Biomedical applications of pion-producing accelerators
– Sumio Makino Medical Equipment Division Toshiba Corporation Hibiya Denden Bldg. 1-1-6, Uchisaiwai-cho Chiyoda-ku, Tokyo 100 Japan	Capability of development of therapeutic accelerators in Japan
– R. A. Fernald New Market Development High Voltage Engineering Corp. Burlington, MA 01803 U.S.A.	Disinfection of municipal sludge and waste water by energized electrons

– Masaaki Takehisa
Research Division
Takasaki Radiation Chemistry Research Establishment
Japan Atomic Energy Research Institute
1233, Watanuki-cho, Takasaki
Gunma 370-12, Japan

Possible application of radiation to sewage sludge treatment in Japan

– Shinichi Ota
Engineering Section
Radiation Department
Sumitomo Electric Ind., Ltd.
950, Noda, Kumatari-cho
Sennan-gun, Osaka 590-04
Japan

Industrial applications of radiation-induced crosslinked polymer

– Eisuke Oda
Nuclear Power Plant Team
Wires and Cables Production Group
The Furukawa Electric Co., Ltd.
5-1-9, Higashi Hachiman
Hiratsuka, Kanagawa 254
Japan

Applications of radiation processing for wire and cable

– Isao Kaetsu
Process Laboratory III
Takasaki Radiation Chemistry Research Establishment
Japan Atomic Energy Research Institute
1233, Watanuki-cho, Takasaki
Gunma 370-12, Japan

Possibility of radiation utilization for development of substitute energy–effective use of biomass

FIFTH AUSTRALIAN SYMPOSIUM ON ANALYTICAL CHEMISTRY

Rudolph J. Marcus

"The Fifth Australian Symposium on Analytical Chemistry" was held 20-24 August 1979, in Perth, Western Australia. Although no one from ONR/Tokyo was at this meeting, the abstracts of papers given at this meeting are available at this office and specific ones can be sent to those who request them.

The Bill Jewell Memorial Lecture was given by Mr. E. J. O'Brien of the State Laboratories in Victoria. Plenary Lectures were given by:

- Professor R. E. Dessy, Virginia Polytechnic Institute and State University
- Dr. B. S. Finkle, University of Utah
- Professor D. H. Freeman, University of Maryland
- Professor G. M. Hieftje, Indiana University
- Dr. G. F. Kirkbright, Imperial College
- Dr. M. W. Skougstad, U.S. Geological Survey
- Dr. R. L. Williams, Metropolitan Police Forensic Science Laboratory.

Invited review lecturers were:

- Dr. P. W. Alexander, The University of New South Wales
- Mr. C. B. Belcher and Dr. K. E. Turner, B. H. P. Central Research Laboratories
- Mr. P. L. Boar, State Electricity Commission of Victoria
- Professor A. M. Bond, Deakin University
- Dr. J. Cable, National Biological Standards Laboratory
- Dr. J. Dunn, W. A. Institute of Technology
- Dr. T. M. Florence, Australian Atomic Energy Commission
- Professor B. Halpern, University of Wollongong
- Mr. E. S. Pilkington, CSIRO Division of Mineral Chemistry
- Dr. J. B. Robinson, Environmental Protection Authority.

A listing of speakers at this meeting, their addresses, and titles of their papers follows.

Name and Address	Title
– M. W. Skougstad U.S. Geological Survey Box 25406, M. S. 417 Denver, Colorado 80225 U.S.A.	Inorganic water-quality assessment: standards, standardization and data substantiation
– G. F. Kirkbright Chemistry Department Imperial College London SW7, U.K.	Applications performance and problems of plasma sources for analytical atomic emission spectroscopy

– B. Halpern
Department of Chemistry
The University of Wollongong
Wollongong, New South Wales
Australia

Biomedical applications of gas chromatography–mass spectrometry

– J. B. Robinson
Air Quality Branch
Environment Protection Authority
240 Victoria Parade
East Melbourne 3002
Victoria, Australia

Environmental standards in Australia

– K. E. Turner and C. B. Belcher
BHP Central Research Laboratories
P.O. Box 188
Wallsend 2287, N.S.W.
Australia

Recent advances in X-ray fluorescence

– M. J. Ashworth and F. H. Farthing
Department of Applied Chemistry
& Applied Biology
Royal Melbourne Institute of Technology
124 La Trobe Street
Melbourne 3000, Victoria
Australia

The analysis of cadmium in marine samples

– J. H. O'Keefe
CSIRO Division of Animal Production
P.O. Box 239, Blacktown
N.S.W. 2148, Australia

The identification and isotopic hydrogen labelling of mimosine

– D. C. McDonald
CSIRO Division of Chemical Physics
P.O. Box 160
Clayton, Victoria 3168
Australia

The possibility of absolute analysis using cathodic sputtering to atomize samples for atomic absorption measurements

– Janos Fazakas
Center for Analytical Spectrochemistry
Bul. Marasi 61
R–71331 Bucharest
Rumania

Optimisation of precision and accuracy with a microprocessor-controlled atomic absorption spectrophotometer

– K. J. R. Rosman and J. R. de Laeter
Department of Physics
Western Australian Institute of Technology
Hayman Road, S. Bentley
Western Australia
Australia

Accurate determination of cadmium in water samples by mass spectrometric isotope dilution

– P. J. Finlayson, R. K. Christopher, and A. M. Duffield
Biomedical Mass Spectrometry Unit
The University of New South Wales
P.O. Box 1
Kensington 2033, N.S.W.
Australia

Quantitation of urinary amino acids by gas chromatography/isobutane chemical ionization mass spectrometry using ^{13}C-amino acids as internal standards

– J. C. Eames
Division of Mineralogy
CSIRO P.O. Box 136
North Ryde, N.S.W. 2113
Australia, and
J. P. Matousek
Department of Analytical Chemistry
University of New South Wales
P.O. Box 1, Kensington
N.S.W. 2033, Australia

Factors affecting the direct determination of silver in silicate rocks by furnace atomic absorption spectrometry

– John J. Fardy, G. D. McOrist, R. E. Porritt, and C. J. Bowles
Chemical Technology Division
Australian Atomic Energy Commission
Private Mail Bag
Sutherland, N.S.W. 2232
Australia

Trace metal analysis techniques by neutraon activation analysis

– N. T. Campbell
Forensic Chemistry Division
Government Chemical Laboratories
30 Plain Street
Perth, West Australia 6000
Australia

Applications of gas chromotography–mass spectrometry in forensic analysis

– E. J. Czobik, J. P. Matousek, and L. E. Smythe
Department of Analytical Chemistry
The University of New South Wales
P.O. Box 1, Kensington
N.S.W. 2033
Australia

Direct temperature control for furnace atomizers used in atomic absorption spectroscopy

– D. Gardner
CSIRO Division of Fisheries and Oceanography
P.O. Box 21
Cronulla, N.S.W. 2230
Australia

The requirement for, design of, and operation of a laminar flow clean-room for trace metal analysis in marine chemistry

– P. R. Liddell and P. C. Wildy
Varian Techtron Pty. Ltd.
679/701 Springvale Road
Mulgrave, Victoria 3170, Australia

Precision and noise in atomic absorption flame spectrometry

– R. W. Cattrall, I. C. Hamilton, and Geat Lean Lee
Department of Inorganic and Analytical Chemistry
La Trobe University
Bundoora, Victoria 3083
Australia

Ion-selective electrodes responsive to chlorocobaltate (II) ions

– Janos Fazakas
Center for Analytical Spectrochemistry
Bul. Marasti 61
R–71331 Bucharest
Rumania

Critical study on the determination of indium by by electrothermal atomisation–atomic absorption spectrometry

– Janos Fazakas
Center for Analytical Spectrocehmistry
Bul. Marasti 61
R–71331 Bucharest
Rumania

Automated sampling systems in electrothermal atomisation atomic absorption

– T. W. Hamilton and J. Ellis
Chemistry Department
The University of Wollongong
Wollongong
New South Wales
Australia, and
T. M. Florence
Analytical Chemistry Section
Australian Atomic Energy Commission
Lucas Heights
New South Wales
Australia

An anodic stripping voltammetric method for the determination of selenium and tellurium in electrolytic copper using a gold-film/glassy carbon electrode

– T. W. Hamilton and J. Ellis
Chemistry Department
The University of Wollongong
Wollongong
New South Wales
Australia, and
T. J. Hunt
Computer Center
Australian Iron & Steel
Wollongong
New South Wales
Australia

An automatic controller for voltammeteric analysis

– A. M. Bond, H. A. Hudson, and P. A. van den Bosch
Division of Chemical and Physical Sciences
Deakin University, Geelong
Victoria 3217, Australia

Continuous flow cells for use in polarography and stripping voltammetry

– J. W. Shortland and G. C. Webb
State Pollution Control Commission, N.S.W.
G.P.O. Box 4036
Sydney 2001, Australia

Implementation of gas-sensing membrane probes for determination of ultimate biochemical oxygen demand in river waters

– R. E. Dessy
Virginia Polytechnic Institute and State University

Chemistry Department
Blacksburg, Virginia 24061
U.S.A.

A rational approach to laboratory automation– concepts and examples

– A. M. Bond
Division of Chemical and Physical Sciences
Deakin University
Waurn Ponds, 3217
Victoria, Australia

Bio-medical applications of electroanalytical techniques

– E. S. Pilkington
CSIRO Division of Mineral Chemistry
P.O. Box 124
Port Melbourne
Victoria, Australia

Development of an international standard

– B. S. Finkle
Center for Human Toxicology
University of Utah
U.S.A.

Setting the pace . . . It takes all the running you can do to stay in the same place, said Alice. (Recent advance in forensic science)

– M. W. Skougstad
U.S. Geological Survey
Denver, Colorado 80225
U.S.A.

Determination of trace and ultratrace elements in water

– J. Cable, E. J. Howard, A. R. Lea, M. A. Johnston and J. M. Kennedy
Pharmaceutical Chemistry Section
National Biological Standards Laboratory
P.O. Box 462 City, Canberra
A.C.T. 2601, Australia

Aspects of the analysis of pharmaceuticals

– G. F. Kirkbright
Chemistry Department
Imperial College
London SW7, U.K.

Analytical optoacoustic spectroscopy: Potential and applications

– Trevor E. Brown
Pancontinental Mining Ltd.
P.O. Box 1575
Darwin, N.T., Australia

The use of new instrumentation to measure low level environmental parameters

– N. L. Wilson
Agricultural Chemistry Division
Government Chemical Laboratories
30 Plain St., Perth
Western Australia
Australia

Rapid determination of low levels of erucic acid in rapeseed

– J. T. Van Gemert
Research Laboratory
Kodak (Australasia) Pty Ltd.
P.O. Box 90
Coburg, Victoria 3058
Australia

The simultaneous determination of halides by *automated potentiometry*

– D. C. Bowditch
Australian Mineral Development Laboratories
Flemington St., Frewville
South Australia 5063
Australia

Analytical methods used in comprehensive environmental programmes

– L. F. Sharry and J. K. O'Keefe
CSIRO Division of Animal Production
Box 239, Blacktown
N.S.W. 2148
Australia

Wax in wool by wide-line nuclear magnetic resonance

– Darryl W. Yaniuk
Executive Officer
Chemical and General Technology Group
Standards Association of Australia
P.O. Box 458
North Sydney, N.S.W. 2060
Australia

The preparation and utilization of certified reference materials in chemical analysis

– V. P. Garnys
Analytical Chemistry Division
Amdel, Flemington Street
Frewville, South Australia 5063
Australia, and
L. E. Smythe
Department of Analytical Chemistry
University of New South Wales
P.O. Box 1, Kensington
New South Wales 2033
Australia

An international interlaboratory survey of lead in blood, digest, saline and water

– E. G. Davidson and P. J. Pearce
Defence Science and Technology Organisation
Materials Research Laboratories
P.O. Box 50, Ascot Vale.
Victoria 3032, Australia

Examination of structural, epoxy-based film adhesives by internal reflectance spectroscopy

– Stephen Altree-Williams
Division of Occupational Health & Radiation Control
Health Commission of New South Wales
P.O. Box 163, Lidcombe
N.S.W. 2141, Australia

Standards for quantitative X-ray powder diffractometry

– K. G. Brodie
Varian Techtron Pty Ltd.
679/701 Springvale Road
Mulgrave, Victoria 3170
Australia

A new vapor generation system for rapid atomic absorption analysis of mercury and volatile hydrides

– A. M. Bond and K. M. Gawne
Division of Chemical and Physical Sciences
School of Science
Deakin University
Geelong, Victoria 3217
Australia

Trace analysis–a comparison between polarographic and atomic absorption spectroscopic techniques

– R. Alexander, P. Lester, and I. Twaddle
Department of Chemistry
Western Australian Institute of Technology
Hyaman Road, Bentley
West Australia 6102
Australia

Measurement of the stable isotope ratios of carbon and hydrogen in petroleum and their application to petroleum exploration

– R. Alexander and G. W. Woodhouse
Department of Chemistry
Western Australian Institute of Technology
Hayman Road, Bentley
West Australia 6102
Australia

Analysis of petroleum in sedimentary rocks and its application to petroleum exploration

– J. D. Blake and M. L. Clark
Sugar Research Institute
Nebo Road, Mackay
Queensland 4740
Australia

Problems experienced in the analysis of organic acids

– D. R. Briggs and Karen A. Pargeter
Section of Human Nutrition
Deakin University
Victoria 3217
Australia

Determination of vasoactive amines and related compounds by high performance liquid chromatography

– G. F. Ebell, D. E. Fleming, J. H. Genovese, and G. A. Taylor
Government Chemical Laboratories
Food & Industrial Hygiene Division
30 Plain Street, Perth
Western Australia 6000
Australia

Simultaneous determination of 2,4- and 2,6-diisocyanatotoluene (TDI) and 3,3'-dichloro-4,4'-diaminodiphenylmethane (MOCA) in air

– R. L. Heazlewood
Department of Pathology
Royal Brisbane Hospital
Herston, Queensland 4029
Australia, and
W. C. Hooper
Department of Medicine
University of Queensland
Royal Brisbane Hospital
Herston, Queensland 4029
Australia

Application of a gas chromatograph-mass spectrometer to elucidate interference in gas chromatography barbiturate screening

– G. Jordan and T. Norris
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A modified sample injector for improved efficiency in high performance liquid chromatography

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Determination of amino acids by glass capillary column chromatography

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The analysis of amino acids by high performance liquid chromatography

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Soil analysis in forensic science

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A screening procedure for the identification of drugs in blood and urine with potential application to traffic offenders

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Chemical analysis of bomb scene detris

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Forensic examination of paints

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Analysis of oils in maritime pollution

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New standards in atomic spectroscopic instrumentation

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From hemlock to heroin: The vicissitudes of analytical toxicology

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Ion selective electrodes

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Recent advances in liquid chromatography

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Forensic applications of scanning electron microscopy

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Electrochemical techniques in water analysis

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New transducers for analysis–surface acoustic wave devices and photodiode arrays

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The determination of endogenous indolealkylamines in biological fluids

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The application of electrodeposition on tungsten wire to furnace atomic absorption spectrometry

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Microwave drying, an alternative to oven drying of biological tissues for trace-element analysis

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A new method for the analysis of nonionic surfactants

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High performance liquid chromatographic investigations of extracts of the hallucinogenic mushroom *Psilocybe subaeruginosa*

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Measurement of chromium speciation in seawater by electrodeposition on graphite tubes for furnace atomic absorption spectrometry

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Electrodeless discharge lamps in atomic fluorescence spectroscopy

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A preliminary survey of petroleum contamination in Cockburn Sound

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Spectroscopic characterisation & quantitation of synthetic melanins

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The improved productivity and performance of a new semi-automated filament in furnace atomization (FIFA) atomic absorption spectrometer

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Determination of rare earth elements in rocks by spark source mass spectrometry using electrical detection

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Sampling and analysis of inorganic constituents in flue gases

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2-mercaptobenzothiazole–a versatile analytical reagent

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Determination of organic mercury in fish

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Direct rapid determination of copper in bovine blood plasma by electrothermal atomisation–atomic absorption spectrometry

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Determination of silver in carbogaseous mineral waters by electrothermal atomisation-atomic absorption spectrometry

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The determination of colbalt, copper, lead, nickel, and zinc in whole blood by atomic absorption spectrohotometry

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Preconcentration of trace metals by extraction into hydrocarbon solvents

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Copper, lead and cadmium in Cockburn Sound seawater by anodic stripping voltammetry

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The determination of copper, zinc, lead, and cadmium in marine tissue. An Australian collaborative/ inter-operator study

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Interference on potassium measurements in plant material by atomic absorption spectroscopy

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Elemental mass balance at a brown coal-fired power station

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Elemental microanalysis. The determination of the metal component

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Trace element analysis of Australian coals by neutron activation analysis

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Direct X-ray fluorescence determination of trace elements in coal

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The analysis of trace organometallic compounds in petroleum

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Determination of uranium in waters by X-ray fluorescence after preconcentration

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Estimation of the human element

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Safety and the analytical laboratory

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Developments in forensic chemistry

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Classification of marine sediments

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High-speed spectroscopy with lasers

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Quantitative applications of thermal methods of analysis

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Graphite furnace atomization atomic absorption spectrometry: Its application, art or science?

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Australian inter-laboratory collaborative studies on analysis of marine environmental pollutants

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A method of analysing sponge iron for forms of iron

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Applications of an inductively coupled plasma spectrometer to the analysis of difficult samples

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Controlling and recovery of laboratory costs

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Determination of water and carbon in rocks and minerals

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Wavelength scanning as an instructional aid in analytical atomic spectrometry

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The preparation of lithium borate fluxes and the selection of optimum fusion mixtures

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Volatile benzotriazole derivatives for the determination of nitrite by gas chromatography

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The determination of sulphide and sulphite in water with the BIS (2.9-dimethyl-1, 10-phenanthroline) copper (II) ion

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Chemical analysis of stony meteorites using a chlorination technique

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Glass transition of cured adhesive films thermo-analytical applications

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